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ALFRED RUSSEL WALLACE, 1823–1913[1]

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ALFRED RUSSEL WALLACE, the last survivor of the great group of British naturalists of the nineteenth century, passed away on November 7, 1913, in the ninety-first year of his age and the sixty-fourth year of active service and productiveness. He followed by only a few months another member of the group, Sir Joseph Hooker, who introduced the famous Darwin-Wallace papers on Natural Selection to the Linnæan Society in 1858.

Lyell, Darwin and Wallace were three successive but closely kindred spirits whose work began and ended with what will be known as the second great epoch of evolutionary thought, the first being that of the precursors of Darwin and the third that in which we live. They established evolution through a continued line of attack by precisely similar methods of observation and reasoning over an extremely broad field. As to the closeness of the intellectual sequence between these three men, those who know the original edition of the second volume of "The Principles of Geology," published in 1832, must regard it as the second biologic classic of the century—the first being Lamarck's "Philosophie Zoologique" of 1809—on which Darwin through his higher and much more creative vision built up his "Journal of Researches." When Lyell faltered in the application of his own principles, Darwin went on, and was followed by Wallace.

The two elder men may be considered to have united in guiding the

[1] An abstract of this biographical sketch appeared in *Nature*, Thursday, June 13, 1912, Vol. 89, No. 2224, entitled, "Scientific Worthies. XXXVIII.—Dr. Alfred Russel Wallace, D.C.L., O.M., F.R.S." The writer had the pleasure of receiving a letter from the veteran naturalist June 16, 1912, in which he wrote: "I thank you very much for the complete and careful account of my scientific work and for the great honor you have done me in linking my name with those of Lyell, Darwin and Galton. Your article is by far the best account of my work and of the various influences which determined its direction and the conclusions at which I have arrived. . . ."

mind of Wallace, because the young naturalist, fourteen years the junior of Darwin, took both "The Principles" of Lyell and "The Journal" of Darwin with him on his journey to South America, during which his career fairly began. From his record of observations during his life in the tropics of America and of Asia Wallace will be remembered not only as one of the independent discoverers of the theory of natural selection but next to Darwin as one of the great naturalists of the nineteenth century. His range and originality are astounding in these days of specialization. His main lines of thought, although in many instances suggested to his mind somewhat suddenly, were developed and presented in a deliberate and masterly way through the series of papers and books extending from 1850 to 1913. The highest level of his creative life was, however, reached at the age of thirty-five when with Darwin he published his sketch of the theory of natural selection. This outburst of original thought, on which his reputation will chiefly rest, came as an almost automatic generalization from his twelve years in the tropics.

Nature and nurture conspire to form a naturalist. Predisposition, an opportune period, and a happy series of events favored Alfred Russel Wallace.

Wallace was the son of Thomas Vere Wallace, of Hanworth, Middlesex, England, and Mary Anne Grennell, of Hertford. His ancestry is obscure. On the paternal side he is probably descended from one of the branches of Sir William Wallace, the popular national hero of Scotland, but nothing is known back of his grandfather, who was probably keeper of the inn on the estates of the Dukes of St. Albans, of Hanworth. The burial records of Hanworth mention an Admiral James Wallace. In his mother's family on the paternal side is the name Greenell, of Hertford, probably the "Greenaile" in 1579, French huguenot refugees after the massacre of St. Bartholomew. Her grandfather was for many years alderman and twice mayor of Hertford. One of the Greenells was an architect.

Wallace's father took up the profession of the law, but did not continue, and up to his marriage lived the life of a fairly well to do middle class gentleman. After his marriage he essayed the publishing of two magazines apparently devoted to art, antiquities and general literature, which were failures. He then moved from Marylebone to more rural districts where living was less expensive, first to St. Georges, Southward, and then to Usk, Monmouthshire. In this village Alfred Russel Wallace was born on January 8, 1823.

When about six years of age the family moved to Hertford, and Wallace's education was begun in the old grammar school, which dated back to 1617. He left school too young to begin Greek but he studied Latin, and next to Latin grammar the most painful subject he learned

was geography, principally because of the meaningless way in which it was taught. During the last year of study at the grammar school as the family were then in very straitened circumstances, he assisted in the teaching of the younger boys in reading, arithmetic and writing.

Wallace considered that his home life in Hertford was in many ways more educational than the time spent at school. His father was a man who enjoyed the pleasure of literature, and belonged to a book club through which a constant stream of interesting books came to the house, from which he read aloud to the family in the evenings. The father earned a small income tutoring and as librarian of a small library, and the son Alfred spent hours reading there, also.

At the age of 13 or 14 young Wallace left school, with a view to learning land surveying. He stayed in London a short time with his brother John, who was apprenticed to a master builder, and their evenings were most frequently spent in the "Hall of Science," a kind of mechanics institute for advanced thinkers among workmen. Here he heard many lectures by Robert Owen, the founder of the socialist movement in England, and took up philosophical reading, beginning with Paine's "Age of Reason" among other books. In the summer of 1837 he went with his brother William into Bedfordshire to begin his education as a land surveyor, and practised for seven years in various parts of England and Wales.

After a time it was decided that he should try to pursue the clock-making business as well as surveying and general engineering, and Wallace considered that this was the first of several turning points in his life, because changes in the business of the clock-making concern with which he was connected at Leighton prevented his continuing this work for more than a short period. He was delighted to take up again in 1839 the employment of land surveying because of the opportunities it afforded for out-of-door life.

While at Neath in Wales there was not much demand for surveying, and Wallace occupied himself in constructing a rude telescope with which he was able to observe the moon and Jupiter's satellites, and he developed much interest in studying astronomy and in the development of astronomical instruments. But he says that he was chiefly occupied with what became more and more the solace and delight of his lonely rambles among the moors and mountains, namely, his first introduction to the variety, the beauty and the mystery of nature as manifested in the vegetable kingdom.

His earnings were very meager, and he had little money for the purchase of books. During the seven years he worked with his brother he says he "hardly ever had more than a few shillings for personal expenses." It was during this period while most occupied out of doors with the observation and collection of plants that he began to write

down more or less systematically his ideas on various subjects that interested him. His first literary efforts all bear dates of the autumn and winter of 1843, when he was between nineteen and twenty years of age. One of his first productions was the rough sketch of a popular lecture on botany addressed to an audience supposed to be as ignorant as he was when he began his observation of the native flowers. A second of these early lectures was on the subject "The Advantages of Varied Knowledge," which he considered of interest chiefly as showing the bent of his mind at the time and indicating a disposition for discursive reading and study. He also wrote at this time on the manners and customs of the Welsh peasantry in Brecknockshire and Glamorganshire, and put the matter in form for one of the London magazines, but it was declined.

These early and serious studies in botany, continuing for four years, prepared him for the plant wonders of the tropics. At the age of twenty-one he came to London. He afterward regarded his difficulty in obtaining employment as a great turning point in his career, "for otherwise," he writes, "it seems very unlikely that I should ever have undertaken what at that time seemed rather a wild scheme, a journey to the almost unknown forests of the Amazon in order to observe nature and make a living by collecting."

In his autobiographic volumes of 1905, "My Life, a Record of Events and Opinions," there is also an interesting sketch of his state of mind at this time.

> I do not think that at this formative period I could be said to have shown special superiority in any of the higher mental faculties, but I possessed a strong desire to know the causes of things, a great love of beauty in form and color, and a considerable, but not excessive desire for order and arrangement in whatever I had to do. If I had one distinct mental faculty more prominent than another it was the power of correct reasoning from a review of the known facts in any case to the causes or laws which produced them, and also in detecting fallacies in the reasoning of other persons.

Elsewhere in his autobiography he observes that whatever reputation in science, literature and thought he may possess is the result of the organs of comparison, causality and order, with firmness, acquisitiveness, concentrativeness, constructiveness and wonder, all above the average, but none of them excessively developed, combined with a moderate faculty of language which

> enables me to express my ideas and conclusions in writing though but imperfectly in speech. I feel, myself, how curiously and persistently these faculties have acted in various combinations to determine my tastes, disposition and actions.

Wallace shared Darwin's strong sentiment for justice as between man and man, and abhorrence of tyranny and unnecessary interference with the liberty of others. His retiring disposition enabled him to enjoy long periods of reflection, receptiveness and solitude, both at home

and in the tropics, out of which have come the sudden illuminations or flashes of light leading to the solution of the problems before him. As to this wonderful mechanism of induction, Wallace observes:

> I have long since come to see that no one deserves either praise or blame for the *ideas* that come to him, but only for the *actions* resulting therefrom. Ideas and beliefs are certainly not voluntary acts. They come to us—we hardly know *how* or *whence*, and once they have got possession of us we can not reject or change them at will.

Apart from Darwin's education in Christ's College, Cambridge, as compared with Wallace's self-education, the parallel between his intellectual tendencies and environment and those of Charles Darwin is extraordinary. They enjoyed a similar current of influence from men, from books and from nature. Thus the next turning point in his life was his meeting with Henry Walter Bates, through whom he acquired his zest for the wonders of insect life, which opened for the first time for him the zoological windows of nature. In a measure Bates was to Wallace what the Rev. John S. Henslow had been to Darwin. It is noteworthy that the greater and most original part of his direct observations of nature were upon the adaptations of insects.

Darwin and Wallace fell under the spell of the same books, first and foremost those of Lyell, as noted above, then of Humboldt in his "Personal Narrative" (1814–18), of Robert Chambers in his "Vestiges of the Natural History of Creation" (1844), of Malthus in his "Essay on the Principle of Population" (1798).

It was, however, Darwin's own "Journal of Researches," published in 1845, and read by Wallace at the age of twenty-three, which determined him to invite Bates to accompany him on his journey to the Amazon and Rio Negro, which filled the four years 1848–52. In this wondrous equatorial expanse, like Darwin he was profoundly impressed with the forests, the butterflies and birds, and with his first meeting with man in an absolute state of nature. Bates, himself a naturalist of high order,[2] was closely observing the mimetic resemblances among insects to animate and inanimate objects and introducing Wallace to a field which he subsequently made his own. Bates remained several years after Wallace's departure, and published his classical memoir on mimicry in 1860–61. Wallace's own description of his South American experiences entitled "Narrative of Travels on the Amazon," published in 1853 when he was thirty years of age, does not display the ability of his later writings, and shows that his powers were slowly developing.

His eight years of travel between 1854 and 1862 in the Indo-Malay Islands, the Timor Group, Celebes, the Moluccas and the Papuan Group brought his powers to full maturity. It is apparent that his prolonged observations on the natives, the forests, the birds and mammals, and

[2] See his principal work, entitled "Naturalist on the River Amazons," 2 vols., 8vo, John Murray, London. 1863.

especially on the butterflies and beetles, were gradually storing his mind for one of those discharges of generalization which come so unexpectedly out of the vast accumulation of facts. "The Malay Archipelago" of 1869, published seven years after the return, is Wallace's "journal of researches," that is, it is to be compared with Darwin's great work of this title. Its fine breadth of treatment in anthropology, zoology, botany and physiography gives it a rank second only to Darwin's "Journal" in a class of works repeatedly enriched by British naturalists from the time of Burchell's journey in Africa.

Wallace's first trial at the evolution problem was his essay sent to the *Annals and Magazine of Natural History* in 1855, entitled "On the Law Which has Regulated the Introduction of New Species." This paper suggested the *when* and *where* of the occurrence of new forms, but not the *how*. He concludes:

> It has now been shown, though most briefly and imperfectly, how the law that "*Every species has come into existence coincident both in time and space with a preexisting closely allied species,*" connects together and renders intelligible a vast number of independent and hitherto unexplained facts.

In February, 1858, during a period of intermittent fever at Ternate, the *how* arose in his mind with the recollection of the "Essay" of Malthus, and there flashed upon him all the possible effects of the struggle for existence. Twenty years before the same idea, under similar circumstances, had come into the mind of Darwin. The parallel is extraordinary as shown in the following citations:

DARWIN	WALLACE
In October, 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement, "Malthus on Population," and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observations of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. *The result of this would be the formation of new species.* Here, then, I had at last got a theory by which to work; but I was so anxious to avoid prejudice that I determined not for some time to write even the briefest sketch of it. In June, 1842, I first allowed myself the satisfaction of writing a very brief abstract of my theory in pencil, in thirty-five pages,	In February, 1858, I was suffering from a rather severe attack of intermittent fever at Ternate, in the Moluccas; and one day, while lying on my bed during the cold fit, wrapped in blankets, though the thermometer was at 88° Fahr., the problem again presented itself to me, and something led me to think of the "positive checks" described by Malthus in his "Essay on Population," a work I had read several years before, and which had made a deep and permanent impression on my mind. These checks—war, disease, famine and the like—must, it occurred to me, act on animals as well as man. Then I thought of the enormously rapid multiplication of animals, causing these checks to be much more effective in them than in the case of man; and while pondering vaguely on this fact there suddenly

and this was enlarged during the summer of 1844 into one of 230 pages.—Darwin's Autobiography, Chap. II.

flashed upon me the *idea* of the survival of the fittest—that the individuals removed by these checks must be on the whole inferior to those that survived. In the two hours that elapsed before my ague fit was over, I had thought out almost the whole of the theory; and the same evening I sketched the draft of my paper, and in the two succeeding evenings wrote it out in full, and sent it by the next post to Mr. Darwin.—Wallace's "My Life," p. 212.

Darwin had been working upon the verification of the same idea for twenty years. We owe to Sir Joseph Hooker and to Lyell the bringing together of these independent but strikingly similar manuscripts. The noble episode which followed of the joint publication of the discovery was prophetic of the continued care for truth and carelessness of self, of the friendship, mutual admiration and cooperation between these two high-minded men, which affords a golden example for our own and future ages. Each loved his own creations, yet undervalued his own work; each accorded enthusiastic praise to the work of the other.

It is a striking circumstance in the history of biology that Wallace's rapidly produced sketch of 1858 "On the Tendencies of Varieties to Part Indefinitely from the Original Type" not only pursues a line of thought parallel to that of Darwin, except in excluding the analogy of natural with human selection, but embodies the permanent substance of the selection theory as it is to-day after fifty-four years of world-wide research. It may be regarded as his masterpiece. The attempt has been made by De Vries and others to show that Wallace in his "Darwinism" of 1889 differed from Darwin on important points, but whatever may be true of this final modification of the theory, a very careful comparison of the Darwin-Wallace sketches of 1858 shows that they both involve the principle of discontinuity; in fact, fluctuation in the sense of plus and minus variation was not recognized at the time; the notion of variation was that derived directly from field rather than from laboratory notes. This is repeatedly implied in Wallace's language and especially in the concluding sentence of his "Sketch" of 1858:

. . . that there is a general principle in nature which will cause many *varieties* to survive the parent species, and to give rise to successive variations departing further and further from the original type, and which also produces, in domesticated animals, the tendency of varieties to return to the parent form. . . .

Most or perhaps all the variations from the typical form of a species must have some definite effect, however slight, on the habits or capacities of the individuals. Even a change of color might, by rendering them more or less distinguishable, affect their safety; a greater or less development of hair might modify their habits. . . . The superior variety would then alone remain, and on a re-

turn to favorable circumstances would rapidly increase in numbers and occupy the place of the extinct species and variety.

The *variety* would now have replaced the *species*, of which it would be a more perfectly developed and more highly organized form. . . . . Here, then, we have *progression and continued divergence* deduced from the general laws which regulate the existence of animals in a state of nature, and from the undisputed fact that varieties do frequently occur. . . . Variations in unimportant parts might also occur, having no perceptible effect on the life-preserving powers; and the varieties so furnished might run a course parallel with the parent species, either giving rise to further variations or returning to the former type. . . . In the wild animal, on the contrary, all its faculties and powers being brought into full action for the necessities of existence, any increase becomes immediately available, is strengthened by exercise, and must even slightly modify the food, the habits and the whole economy of the race. It creates, as it were, a new animal, one of superior powers, and which will necessarily increase in numbers and outlive those inferior to it. . . .

We see, then, that no inferences as to varieties in a state of nature can be deduced from the observation of those occurring among domestic animals. . . . Domestic animals are abnormal, irregular, artificial; they are subject to varieties which never occur and never can occur in a state of nature: their very existence depends altogether on human care; so far are many of them removed from that just proportion of faculties, that true balance of organization . . . will also agree with the peculiar character of the modifications of form and structure which obtain in organized beings—the many lines of divergence from a central type, the increasing efficiency and power of a particular organ through a succession of allied species, and the remarkable persistence of unimportant parts, such as color, texture of plumage and hair, form of horns or crests, through a series of species differing considerably in more essential characters. . . . This progression, by minute steps, in various directions, but always checked and balanced by the necessary conditions, subject to which alone existence can be preserved, may, it is believed, be followed out so as to agree with all the phenomena. . . .

It is true that Wallace subsequently modified his theory, adopted the selection of plus and minus fluctuations, and became a determined opponent of the mutation hypothesis of De Vries.

The distinctive features of the later development of the theory in Wallace's mind were his more implicit faith in selection, his insistence on utility or selection value of new or varying characters, his flat rejection of Lamarckism, his reliance on spontaneous variations as supplying all the materials for selection. This confidence appears in the following passages from his militant reply in the volume of 1889 to the critics of Darwinism:

The right or favorable variations are so frequently present that the unerring power of natural selection never wants materials to work upon. . . . The importance of natural selection as the one invariable and ever-present factor in all organic change and that which can alone have produced the temporary fixity combined with the secular modification of species.

The principle of discontinuity is less clearly brought out than in the first sketch of 1858; the selection of fluctuation is favorably considered. The laws and causes of variation are, however, assumed rather than

taken up as a subject of inquiry. These opinions of 1889 were the summation of twenty-nine years of work.

To return to the life narrative, the autumn of 1860 found Wallace in the Moluccas reading the "Origin of Species" through five or six times, each time with increasing admiration. A letter of September 1 to his friend George Silk contains the key to the subsequent direction of his research, namely, his recognition of the vast breadth of Darwin's principles and his determination to devote his life to their exposition:

> I could *never have approached* the completeness of his book, its vast accumulation of evidence, its overwhelming argument, and its admirable tone and spirit. I really feel thankful that it has *not* been left to me to give the theory to the world. Mr. Darwin has created a new science and a new philosophy; and I believe that never has such a complete illustration of a new branch of human knowledge been due to the labors and researches of a single man. Never have such vast masses of widely scattered and hitherto quite unconnected facts been combined into a system and brought to bear upon the establishment of such a grand and new and simple philosophy.

The discovery of "Natural Selection" again turned the course of Wallace's life. In his autobiography he writes:

> I had, in fact, been bitten with the passion for species and their description, and if neither Darwin nor myself had hit upon "natural selection," I might have spent the best years of my life in this comparatively profitless work, but the new ideas swept all this away. . . . This outline of the paper will perhaps enable my readers to understand the intense interest I felt in working out all these strange phenomena, and showing how they could almost all be explained by that law of "Natural Selection" which Darwin had discovered many years before, and which I also had been so fortunate as to hit upon.

The coloring of animals as observed in the tropics and the Malayan Islands was the subject in which Wallace made his most extensive and original contributions to Darwinism. In his "Sketch" of 1858–9 he wrote:

> Even the peculiar colors of many animals, especially insects, so closely resembling the soil or the leaves or the trunks on which they habitually reside, are explained on the same principle; for though in the course of ages varieties of many tints may have occurred, *yet those races having colors best adapted to concealment from their enemies would inevitably survive the longest.*

Returning from the Archipelago in 1862, he published in 1864 his pioneer paper, "The Malayan Papilionidæ or Swallow-tailed Butterflies, as illustrative of the Theory of Natural Selection," in which he at once took rank beside Bates and Müller as one of the great contributors to the color characteristics of animals. We see him step by step developing the ideas of protective resemblance which he had fully discussed with Bates, of alluring and warning colors, and of mimicry, pointing out the prevalence of mimicry in the female rather than in the male. The whole series of phenomena are believed to depend upon the great principle of the utility of every character, upon the need of color protection by almost all animals, and upon the known fact that no characteristic is so

variable as color, that, therefore, concealment is most easily obtained by color modification. Protective resemblance in all its manifold forms has ever been dominant in his mind as a greater principle than that of the sexual selection of color which Darwin favored.

Here may be cited Wallace's own account of his famous observation of mimicry in the leaf butterfly from his volume of 1869, "The Malay Archipelago":

> The other species to which I have to direct attention is the *Kallima paralekta*, a butterfly of the same family group as our Purple Emperor, and of about the same size or larger. Its upper surface is of a rich purple, variously tinged with ash color, and across the fore wings there is a broad bar of deep orange, so that when on the wing it is very conspicuous. This species was not uncommon in dry woods and thickets, and I often endeavored to capture it without success, for after flying a short distance it would enter a bush among dry or dead leaves, and however carefully I crept up to the spot I could never discover it till it would suddenly start out again and then disappear in a similar place. At length I was fortunate enough to see the exact spot where the butterfly settled, and though I lost sight of it for some time, I at length discovered that it was close before my eyes, but that in its position of repose it so closely resembled a dead leaf attached to a twig as almost certainly to deceive the eye even when gazing full upon it. I captured several specimens on the wing, and was able fully to understand the way in which this wonderful resemblance is produced. . . . All these varied details combine to produce a disguise that is so complete and marvellous as to astonish every one who observes it; and the habits of the insects are such as to utilize all these peculiarities, and render them available in such a manner as to remove all doubt of the purpose of this singular case of mimicry, which is undoubtedly a protection to the insect.

In 1867, in a manner which delighted Darwin, Wallace advanced his provisional solution of the cause of the gay and even gaudy colors of caterpillars as warnings of distastefulness. In 1868 he propounded his explanation of the colors of nesting birds, that when both sexes are conspicuously colored, the nest conceals the sitting bird, but when the male is conspicuously colored and the nest is open to view, the female is plainly colored and inconspicuous. His theory of recognition colors as of importance in enabling the young of birds and mammals to find their parents was set forth in 1878, and he came to regard it as of very great importance.

In "Tropical Nature" (1878) the whole subject of the colors of animals in relation to natural and sexual selection is reviewed, and the general principle is brought out that the exquisite beauty and variety of insect colors has not been developed through their own visual perceptions, but mainly and perhaps exclusively through those of the higher animals which prey upon them. This conception of color origin, rather than that of the general influence of solar light and heat or the special action of any form of environment, leads him to his functional and biological classification of the colors of living organisms into five groups, which forms the foundation of the modern more extensive and critical classification of Poulton. He concluded (p. 172):

We find, then, that neither the general influence of solar light and heat, nor the special action of variously tinted rays, are adequate causes for the wonderful variety, intensity and complexity of the colors that everywhere meet us in the animal and vegetable worlds. Let us, therefore, take a wider view of these colors, grouping them into classes determined by what we know of their actual uses or special relations to the habits of their possessors. This, which may be termed the functional and biological classification of the colors of living organisms, seems to be best expressed by a division into five groups, as follows:

Animals.
1. Protective colors.
2. Warning colors. *a*. Of creatures specially protected. *b*. Of defenceless creatures, mimicking *a*.
3. Sexual colors.
4. Typical colors.

Plants.
5. Attractive colors.

Twelve years later he devoted four chapters of his "Darwinism" to the colors of animals and plants, still maintaining the hypotheses of utility, of spontaneous variation and of selection.

The study of geographic distribution of animals also sprang from the inspiration of the Malayan journey and from the suggestiveness of the eleventh and twelfth chapters of "The Origin of Species" which Wallace determined to work out in an exhaustive manner. Following the preliminary treatises of Buffon, of Cuvier and Forbes, and the early regional classification of Sclater, Wallace takes rank as the founder of the science of zoogeography in his two great works, "The Geographical Distribution of Animals" of 1876, and "Island Life" of 1881, the latter volume following the first as the result of four years of additional thought and research. His early observations on insular distribution were sketched out in his article of 1860, "The Zoological Geography of the Malayan Archipelago."

Here is his discovery of the Bali-Lombok boundary line between the Indian and the Australian zoological regions which has since been generally known by his name.

In these fundamental geologic and geographic works Wallace appears as a disciple of Lyell in uniformitarianism, and a follower of Dana as regards the stability and permanence of continental and oceanic areas, for which doctrine he advances much original evidence. He taxes his ingenuity to discover every possible means of dispersal of animals and plants other than those which would be afforded by hypothetical land connections; he considers every possible cause of extinction other than those which are sudden or cataclysmal.

The "Island Life" is in itself a great contribution to zoology and zoogeography, the starting point of all modern discussion of insular faunas and floras. His conservative theory of dispersal is applied in an original way to explain the arctic element in the mountain regions of the tropics, as opposed to the low-temperature theory of tropical lowlands during the Glacial Period; his explanation is founded on known facts as to the dispersal and distribution of plants, and does not require the

extreme changes in the climate of tropical lowlands during the Glacial Period on which Darwin founded his interpretation. The causes and influence of the Glacial Epoch are discussed in an exposition of Croll's theory. In this connection may be mentioned one of Wallace's original geological contributions, in the article "Glacial Erosions of Lake Basins," published in 1893, namely, his theory of glacial erosion as a means of explaining the origin of valley lakes of glaciated countries.

The original trend of Wallace's thought as to the ascent of man is first shown in the three anthropological essays of 1864, 1869 and 1870, which were subsequently collected in the volume "Contributions to the Theory of Natural Selection." This work, published in 1871, includes all his original essays from 1855 to 1869 on selection, on color and human evolution, which foreshadow the later development of his speculative philosophy.

A suggestive anthropological contribution is the article entitled "The Expressiveness of Speech or Mouth Gesture as a Factor in the Origin of Language," in which is developed the theory of the origin of language in connection with the motions of the lips, jaws and tongue. With Wallace also arose the now widely accepted belief that the Australian aborigines constitute a low and perhaps primitive type of the Caucasian race.

In the article of 1864, "The Development of Human Races under the Law of Natural Selection," Wallace first advanced the hypothesis which has since proved to be untenable that so soon as man learned to use fire and make tools, to grow food, to domesticate animals, to use clothing and build houses, the action of natural selection was diverted from his body to his mind, and thenceforth his physical form remained stable, while his mental faculties improved. His subsequent papers on human evolution, "The Limits of Natural Selection as Applied to Man" of 1869, "On Instinct in Man and Animals" of 1871, mark the gradual divergence of his views from those of Darwin, for in his opinion natural selection is believed to be inadequate to account for several of the physical as well as psychical characteristics of man, for example his soft, sensitive skin, his speech, his color sense, his mathematical, musical and moral attributes. He concluded:

> The inference I would draw from this class of phenomena is that a superior intelligence has guided the development of man in a definite direction, and for a special purpose, just as man guides the development of many animal and vegetable forms.

It is also prophetic of his later indictments of the so-called civilization of our times that we find at the end of the closing pages of "The Malay Archipelago" the first statement of the feeling which so many travellers have experienced from a comparison of the natural and so-called civilized condition of man that "social evolution from barbarism

to civilization" has not advanced general human welfare. These humanitarian and partly socialistic ideas are developed in a series of recurrent essays between 1882 and 1903, including "The Nationalization of Land," and "Studies Scientific and Social."

He returned to this subject in what we believe to be his last published essay, namely, his "Social Environment and Moral Progress" of 1913, wherein he considers the so-called "feministic" movement and future of woman:

> The foregoing statement of the effect of established natural laws, if allowed free play under rational conditions of civilization, clearly indicates that the position of woman in the not distant future will be far higher and more important than any which has been claimed for or by her in the past.
>
> While she will be conceded full political and social rights on an equality with men, she will be placed in a position of responsibility and power which will render her his superior, since the future moral progress of the race will so largely depend upon her free choice in marriage. As time goes on, and she acquires more and more economic independence, *that* alone will give her an effective choice which she has never had before. But this choice will be further strengthened by the fact that, with ever-increasing approach to equality of opportunity for every child born in our country, that terrible excess of male deaths, in boyhood and early manhood especially due to various preventable causes, will disappear, and change the present majority of women to a majority of men. This will lead to a greater rivalry for wives, and will give to women the power of rejecting all the lower types of character among their suitors.
>
> It will be their special duty so to mould public opinion, through home training and social influence, as to render the women of the future the regenerators of the entire human race.

In closing this review of a great life, we can not refrain from reflecting on the pendulum of scientific opinion. The discovery of a great truth such as the law of Selection is always followed by an over-valuation, from which there is certain to be a reaction. We are in the midst of such a reaction at the present time, in which the Darwin-Wallace theory of natural selection is less appreciated than it will be in the future when there comes a fresh readjustment of scientific values.

It is well to remember that we may not estimate either the man of science or his conclusions as of our own period, but must project ourselves in imagination into the beginnings of his thought and into the travails of his mind, considering how much larger he was than the men about him, how far he was an innovator, breaking away from the traditions of his times, how far his direct observations apart from theory are true and permanent, and how far his theories have contributed to the great stream of biological thought.

Our perspective has covered a long, honorable span of sixty-five years into the beginnings of the thinking life of a natural philosopher whose last volume, "The World of Life," of the year 1911, gives as clear a portrayal of his final opinions as that which his first essay of 1858 portrays of his early opinions.

We follow the cycle of his reflection beginning with "adaptation" as the great mystery to be solved; in the middle and sanguine period of life, "adaptation" is regarded as fully explained by natural selection; in the closing and conservative period of life "adaptation" is again regarded in some of its phases as entirely beyond human powers of interpretation, not only in the evolution of the mental and spiritual nature of man, but in such marvelous manifestations as the scales of butterflies or the wings of birds.

From our own intellectual experience we may sympathize with the rebound of maturity from the buoyant confidence of the young man of thirty-five who finds in natural selection the entire solution of the problem of fitness which has vexed the mind and aroused the scientific curiosity of man since the time of Empedocles. We have ourselves experienced a loss of confidence with advancing years, an increasing humility in the face of transformations which become more and more mysterious the more we study them, although we may not join with this master in his appeal to an organizing and directing supernatural principle. Younger men than Wallace, both among the zoologists and philosophers of our own time are giving a somewhat similar metaphysical solution of the eternal problem of adaptation, which still baffles and transcends our powers of experiment and of reasoning.

LIST OF BOOKS OF ALFRED RUSSEL WALLACE, O.M., F.R.S., ETC.

Sent to the author of the present article in a letter of May 3, 1912.

"In accordance with your request I herewith send you a list of my published books. The delay has been caused by the only complete copy I had having been sent away for publication.

"I have always intended to make out a complete list of my various communications to periodical literature, but have hitherto been unable to find time to do so. All my scientific communications, however, will be found in the *Royal Society's* Catalogue of Scientific Papers which no doubt you have access to."

1. "Palm Trees of the Amazon and their Uses." Pub. 1853.
2. "A Narrative of Travels on the Amazon and Rio Negro, with an Account of the Native Tribes and Observations on the Climate, Geology and Natural History of the Amazon Valley." Pub. 1853, new edition 1889.
3. "The Malay Archipelago, the Land of the Orang-utan and the Bird of Paradise. A Narrative of Travel with Studies of Man and Nature." First edition 1869 (2 vols.). Tenth edition 1898 (1 vol.).
4. "Contributions to the Theory of Natural Selection." Pub. as single vol. 1870. Pub. with "Tropical Nature" in 1 vol. 1891.
5. "Miracles and Modern Spiritualism." Pub. 1874. Revised edition 1896.
6. "The Geographical Distribution of Animals, with a Study of the Relation of Living and Extinct Faunas as Elucidating the Past Changes of the Earth's Surface." Pub. 1876 (2 vols.).
7. "Tropical Nature and Other Essays." Pub. 1 vol. 1878. Pub. with "Natural Selection" in 1 vol. 1891.
8. "Australasia." Stanford's Compendium of Geography and Travel. Pub. 1879, 3d edition 1883. New edition 1893, 1st vol., "Australia and New Zealand."

9. "Island Life or the Phenomena and Causes of Insular Faunas and Floras, including a Revision and Attempted Solution of the Problem of Geological Climates." Pub. 1880. Third and revised edition 1902.
10. "Land Nationalization, its Necessity and its Aims; being a Comparison of the System of Landlord and Tenant with that of Occupying Ownership in their Influence on the Well-being of the People." Pub. 1882.
11. "Bad Times. An Essay on the Present Depression of Trade, Tracing it to its Sources in Enormous Foreign Loans, Excessive War Expenditure, the Increase of Speculation and of Millionaires, and the Depopulation of the Rural Districts; with Suggested Remedies." Pub. 1885.
12. "Darwinism. An Exposition of the Theory of Natural Selection with Some of its Applications." Pub. 1889.
13. "The Wonderful Century. The Age of New Ideas in Science and Invention." Pub. 1898. New ed. revised and largely rewritten 1903.
14. "The Wonderful Century Reader." Pub. 1901.
15. "Studies, Scientific and Social." 2 vols. Pub. 1900.
16. "Man's Place in the Universe. A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds." Pub. 1903. Fourth ed. 1904 (revised).
17. "Is Mars Habitable? A Critical Examination of Professor Percival Lowell's Book 'Mars and its Canals,' with an Alternative Explanation." Pub. 1907.
18. "My Life, a Record of Events and Opinions." Pub. 2 vols. 1905. New ed., 1 vol., revised 1908.
19. "Notes of a Botanist on the Amazon and Andes, being Records of Travel on the Amazon and its Tributaries, the Trombetes, Rio Negro, Napis, Casiquiari, Pacimoni, Huallaga and Pastasa; as also to the Cataracts of the Orinoco, along the Eastern Side of the Andes of Peru and Ecuador, and the Shores of the Pacific, during the years 1849–64." By Richard Spruce, Ph.D., edited and condensed by Alfred Russel Wallace, O.M., F.R.S., etc., with a biographical introduction, portrait, illustrations and maps. 2 vols. Pub. 1908.
20. "The World of Life, a Manifestation of Creative Power, Directive Mind and Ultimate Purpose." Pub. 1910.

The Royal Society Catalogue of Scientific Papers, covering the years 1800–1883, lists ninety-five papers and books by Wallace, the first dated 1850, and his subsequent communications will be found in *The Zoological Record* and *The International Catalogue of Scientific Literature*, which cover the field from the time the *Royal Society Catalogue* ceased.

THE STRUGGLE FOR EQUALITY IN THE UNITED STATES

By Professor CHARLES F. EMERICK
SMITH COLLEGE

Introduction

THE student of public affairs finds much in the course of nineteenth-century development in which the friends of orderly progress may well take heart. For one thing, the world underwent a great advance materially. In 1800, the appliances for producing wealth and the modes of transportation did not differ greatly from those that had been in vogue for hundreds of years. If the men of the fifteenth century could have been brought back to life three centuries later, they would have found the world in these respects substantially what it was when they lived and died. The nineteenth century supplied the world for the first time with the conditions of comfortable living. But it did something more. It contributed greatly to the advance of knowledge and to the diffusion of enlightenment. It witnessed a tremendous increase in the spirit of humanitarianism and the sense of justice. More of the material comforts of life, greater knowledge and enlightenment, and a keener sense of brotherhood and justice have gone hand in hand. The three have, for the most part, been in accord, but occasionally the facts of the material situation have failed to conform to the demands of the other two. It is the purpose of these pages to consider how two or three of these conflicts have contributed to our progress as a nation, and more particularly to discuss certain phases of the existing situation.

The Declaration of Independence

Equality and private property are the two things dear to the American heart. The influence of frontier conditions where one man socially is as good as another and where every one is a potential, if not an actual, owner of land, has stimulated a high regard for the former. On the other hand, in addition to the need of property which civilized man the world over experiences, the environment has been peculiarly favorable in arousing in nearly every one the desire to better his economic condition. In the absence of titled rank, the acquisition of property has been the chief stepping stone to political and social recognition. Besides, immigration has added to our population large numbers in whom the acquisitive instinct is exceptionally strong. The very richness of the rewards open to men of energy and intelligence has given zest to the economic struggle. It may well be, therefore, that the desire to get on

in life is stronger in the United States than in any of the countries of Europe. Relatively to the desire for equality, however, private property is held in no higher esteem here than elsewhere. The American people are no more disposed to sacrifice their ideals to the pursuit of money than are the people of other lands. Among other evidences that this is true are the numerous communistic societies that have sprung up from time to time in the face of repeated failure.

In the main, the passion for equality and the desire for property have not been incompatible. On occasion, however, the two have conflicted and an epoch-making event has occurred in our politics. Moreover, public opinion has not always held the two in equal esteem, but has at times been more devoted to the one and then again to the other. At the outset the emphasis was upon equality. "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain inalienable rights, that among these are Life, Liberty, and the pursuit of Happiness," runs the Declaration of Independence. These words are not to be taken in the sense that every one should wear the same sort of clothes, live in the same kind of a house, eat the same quantity and variety of food, or receive the same economic rewards and social recognition in life. Common sense and the intense individualism of the times are both opposed to any such narrow view as this. The American ideal of equality never has called for a dead level of uniformity. Owing to the strong dislike for anything that savors of titled rank or caste, there was once a popular objection to the wearing of uniforms, even by railroad conductors, but the objection was withdrawn when the practical utility of such uniforms was perceived. The colonists were no less intent upon liberty than upon equality, and their conception of the latter included a generous measure of the former. Equal in some respects, namely, in the right to life, liberty and the pursuit of happiness, was Lincoln's interpretation.[1]

The Declaration of Independence was occasioned by the commercial restrictions of Great Britain. To secure freedom from these restrictions the right of self-government was asserted. More fundamental, however, than British commercial policy were the spirit of independence, the sense of self-reliance and the craving for freedom which isolation from the mother country and other conditions of frontier life helped to develop.

The colonists were more self-reliant than even the original, self-reliant British stock, since, broadly speaking, only selected men essayed the ocean journey. No aid from a hostile, Stuart-ruled England could reach the colonist, who, separated from his neighbors by miles of treacherous forest, was compelled to rely upon himself. With the aid of his family, he plowed his acres, shot his

[1] Debates of Lincoln and Douglas, published by Follett, Foster and Co., Columbus, Ohio, p. 63.

game, caught his fish, made his soap and candles, dressed and cured his leather, spun and wove, did his carpentering, and sometimes his smithing. He made what he ate, wore and lived in, and he made and held his own opinions. His philosophy was that of the lonely, self-contained farmhouse.[2]

This philosophy constituted the idealism of a nation and found expression in the Revolution. Fairly within the spirit of the times was the thought that every man should be given an even chance to realize the best there is in him, and that the strong ought not to use their strength or cunning to despoil the weak. This thought is implied in many of the grounds on which the king of Great Britain was indicted. To equality in some such sense as this the signers of the Declaration of Independence pledged their lives, their fortunes and their sacred honor.

The Constitution

The Revolutionary War was attended with a good deal of turbulence and insecurity of life and property. The property of many of the Loyalists was confiscated and they themselves were forced into exile. Nor was the condition of affairs satisfactory in the years following the treaty of Paris in 1783. The governmental system was notoriously out of accord with the demands of the economic situation. The central government was dependent upon the states for support and its credit was at low ebb. The revolutionary bills of credit reached the last stages of depreciation. Some of the states levied hostile tariffs against each other, or were at loggerheads over the control of the navigable rivers which separated them. The tariff policies and schedules of the several states were woefully lacking in unity. English statesmen questioned the ability of congress to enforce the provisions of any commercial agreement that might be entered into, and Spain continued to claim both banks of the Mississippi.[3] The result was that many tired of the ideal of equality. Moreover, the "hard times" which followed the Revolution and the return of some of the Loyalists contributed to the reaction.

The framing and adopting of the constitution were the logical outcome of the situation. The new government was given the unquestioned power to levy and collect the taxes needed for its own support, and was granted the exclusive power over interstate and foreign commerce. The treaty-making power and the control of the monetary system of the country were definitely and firmly lodged in its hands. These grants of power did much toward making the new government a tower of strength, and that property was thereby rendered more secure there can be no doubt. The cause of equality was also advanced. Federal control of interstate and foreign commerce opened wide the door of indus-

[2] Walter E. Weyl, "The New Democracy," p. 37.

[3] Katherine Coman, "Industrial History of the United States," new and revised edition, 1910, pp. 115–116.

trial opportunity, and a more stable political order made for the spirit of fair play among men. But in the main, the government instituted in 1789 appealed to the property-loving instinct rather than to the idealism of the nation. The assumption of state debts, the establishment of the United States Bank, the enactment of a protective tariff, policies espoused by Hamilton, all tended to enlist men of substance on the side of the government.

The mode provided for amending the constitution contributed to the same end. A two thirds majority of both houses of congress, or a convention called on application of two thirds of the states, is necessary to propose an amendment, and ratification either by conventions or legislatures in three fourths of the states is required for its adoption. The people have no direct voice either in proposing or in adopting amendments, and the obstinacy of a group of states containing a small minority of the population may effectually block the will of states containing an overwhelming majority. According to Walter E. Weyl, less than one fortieth of the voters may block the will of the remaining thirty-nine fortieths.[4] So difficult is the mode of amendment that with the exception of the first twelve amendments, the first ten of which were the price paid to secure the adoption of the constitution and all of which were added shortly after its ratification, the only others are the three resulting from the Civil War and the two recently added. But for military occupation of the southern states, it is doubtful whether all the war amendments would have been ratified by the requisite number of states. In no democratic country are property owners more secure against innovations in the organic law. In England, the power to amend the constitution is vested in the House of Commons. In France, an absolute majority of the two houses in joint session suffices. And in Switzerland, proposed amendments are adopted by a majority of all the votes cast at a popular election provided a majority in a majority of the cantons is at the same time received. The federal constitution of Australia has copied this provision.[5]

Our constitutional system further safeguards property by the system of checks and balances, a leading feature of which is the federal courts. The power to override an act of congress is exercised by an appointive judiciary holding office for life whose compensation "shall not be diminished during their continuance in office." The fifth amendment prohibits congress from depriving any one "of life, liberty, or property, without due process of law," and the fourteenth amendment imposes the same prohibition upon the states. Property is mentioned along with life and liberty implying that it is either on a par with or is necessary to them. As the watch-dogs of both these amendments stand the federal

[4] *Op. cit.*, p. 14.

[5] J. Allen Smith, "The Spirit of American Government," pp. 62–63.

courts. Moreover, judicial interpretation has given a scope to certain clauses of the constitution which no one suspected at the time of their adoption. In the Dartmouth College case in 1819, the Supreme Court held that a charter is a contract, and in a case involving the Southern Pacific Railroad in 1882 the same court interpreted the word "person" to include a corporation. In the former case, the court enlarged the conception of property, and in the latter case, in interpreting an amendment intended for the protection of the negro, the court included under its guardianship the property of artificial as well as of natural persons. The Supreme Court has well been termed "the bulwark of private property." President Hadley aptly remarks:

> When it is said, as it commonly is, that the fundamental division of powers in the modern State is into legislative, executive and judicial, the student of American institutions may fairly note an exception. The fundamental division of powers in the Constitution of the United States is between voters on the one hand and property owners on the other. The forces of democracy on one side, divided between the executive and the legislature, are set over against the forces of property on the other side, with the judiciary as arbiter between them; the constitution itself not only forbidding the legislature and executive to trench upon the rights of property, but compelling the judiciary to define and uphold those rights in a manner provided by the constitution itself.[6]

These remarks were originally delivered at Berlin University. To the average investor, both at home and abroad, they describe what appears to be an ideal situation. On the other hand, to a democracy seeking to possess more fully the reins of power they indicate a condition that is far from satisfactory.

Slavery

A short time after the election of Washington, a reaction set in against the party of property. The commanding personality of Washington and the high respect in which he was held for a brief period stemmed the reaction but could not avert it. The election of Jefferson marked the triumph of the party of equality, a triumph which the westward drift of population and the successive admission of trans-Allegheny states helped to perpetuate. Kentucky was admitted as a state in 1792, Tennessee in 1796, Ohio in 1802, and in the ten years ending with 1821, Louisiana, Indiana, Mississippi, Illinois, Alabama, Maine and Missouri joined the family of states, a greater number than in any decade before or since. The Louisiana purchase sealed the fate of the Federalist party. The ideal of equality in the United States is greatly indebted to the circumstances which have made it possible for such large numbers to become the owners of land in their own right. The liberalization of the terms on which the public lands were offered for sale in 1800, and in the years following, contributed powerfully to the growing prevalence of democratic equality. This found expression in the grad-

[6] *The Independent*, Vol. LXIV, 1908, p. 837.

ual broadening of the suffrage in the different states, in the abolishment of religious and property qualifications for office, in the election of Jackson and the spoils system, and in the war on the United States Bank.

The economic situation rendered the craving for property in the main at one with the ideal of equality. The one noteworthy exception was property in human chattels against which the forces of equality protested until the close of the Civil War. In colonial days African slavery was an American institution. But gradually slavery died out in the north, as the fact that it did not pay became more generally recognized, and even in the south, except in South Carolina and Georgia, the feeling against the institution as late as 1790 was strong. Two events, just at this juncture, the invention of the cotton gin and the introduction of short staple cotton adapted to the uplands of the south, made slave ownership much more profitable and changed the whole situation. The simultaneous introduction of spinning and weaving by steam-driven machinery greatly reduced the cost of manufacturing cotton goods and, aided by improved transportation, brought them into general use, enlarged the market for the product of the cotton fields, hastened the spread of slavery and helped to fasten it more firmly upon the south. Improved transportation also contributed to this result by rendering the interior of the south accessible to the cotton manufacturing centers. Likewise, the growing of slaves in the border states for the southern market became more profitable, and public opinion in these states which had been half way friendly to emancipation suddenly recoiled. As a consequence, slavery ceased to be a national and became a sectional institution. The explanation is at bottom economic, for while slavery as a method of applying labor disappeared in the north, the slave trade continued for some years, even after it had been made unlawful, and was the foundation of not a few fortunes in Newport and other northern cities. Slavery died out in the north because it did not pay, while northerners continued to traffic in slaves because it was profitable. Under the same economic conditions, the southerner is ethically the peer of the northerner.

Property in human beings conflicted with the ideal of equality. So long as one individual owns the body of another, the conception of fair play is set at naught. Not only is the slave denied the freedom necessary to the expression of his personality, but the effect upon the owner is apt to be degrading. The aspirations for better things of both master and slave are either restrained or suppressed. Clearly, slavery was inconsistent with the professions of democracy and was out of accord with the spirit of nineteenth-century civilization. The inconsistency was so glaring that the authors of the constitution scrupulously avoided the use of the words "slave" and "slavery" in framing that document. It would have been strange, therefore, if the restraint and abolition of slav-

ery had not become the goal of the devotees of equality, especially since its inhumanity appeared more obvious and the situation more grotesque as the institution assumed greater proportions.

In the contest which ensued, the abolishment of the African slave trade was the first great event. The power of congress over foreign commerce was in this regard abridged by the constitution till 1808. But promptly upon the expiration of the time limit, the importation of slaves was prohibited. Subsequently, the antagonism between equality and property in slaves was seldom in abeyance, but the enactment of the Missouri compromise in 1820, its repeal in 1854, the Dred Scott decision, and the Civil War were the four events of chief importance. The first prohibited slavery in the territories north of 36° 30′. This was in keeping with the spirit of the ordinance of 1787, and marked a triumph for the advocates of equality. The second and third were victories for the defenders of property in slaves but proved to be only temporary triumphs. The crystallization of public opinion in the north against the spread of slavery in the territories, and the rapid growth of population in the free states threatened its very existence. The tide of events was so strongly against the institution that southern leaders felt that delay was fatal, and resolved to submit the issue to the sword. The fortunes of war turned against them and resulted in a loss of slave property of two thousand millions of dollars.[7] In the enthusiasm of the moment the tide toward equality was so strong that three amendments were added to the constitution. The first declared the negro a free man, the second made him a citizen, and the third aimed at giving him the ballot on a parity with whites. Doubtless the glamor of military success coupled with resentment toward the south and the desire to place the ballot in hands loyal to the federal government contributed to this result. None the less, the three war amendments suggest how dear the ideal of equality is to the American heart.

The Dred Scott Decision

It is worth while to pause long enough here to consider briefly two features of the Dred Scott decision. The first is the rule of judicial interpretation which guided the majority of the court. In the light of precedent and of the law narrowly and strictly interpreted, many lawyers to-day hold the decision handed down by Judge Taney to have been correct. But of those who subscribe to this view, a small but respectable minority maintain that the decision was none the less erroneous on the ground that it is the business of the courts to make precedents as well as to be bound by them and to this end to interpret and apply the law broadly in the light of the prevailing sense of justice. According to this view there is no such hard and fast line of cleavage between the func-

[7] Blaine, "Twenty Years of Congress," Vol. 1, p. 174.

tions of the legislative and judicial departments as is sometimes supposed, and in rendering decisions the courts on occasion make the law as well as declare what the law is. For the courts in their rulings to avoid any recognition of a higher sense of justice in the community until it has found expression in a legislative enactment seems a travesty upon justice to those who hold this position. There is little doubt that the unpopular reception accorded the Dred Scott decision was based upon some such view as this. In point of fact, there is a large body of judge-made law. Some decisions have even gone further and have amended the constitution by interpretation, a procedure which the difficulty of formally amending our organic law invites. In the opinion of many legal lights, Justice Harlan had good ground for accusing the majority of reading the word "reasonable" into the anti-trust act in the Standard Oil and American Tobacco Company cases.

The second feature of the Dred Scott decision to which it is desired to allude here is the storm of popular disapproval which greeted its announcement. The present age is familiar with the heated discussions to which the judicial determination of cases involving the ideals of democracy and the rights of property frequently give rise. Both parties to such controversies have so much at stake that it is hard for either to be a good loser. When anything that a man has once possessed himself of is placed in jeopardy, or when any ideal upon which the fortunes of humanity are supposed to rest is called in question, a complacent mood is too much to expect. Nor is this peculiar to this age. Those who assume that failure to acquiesce cheerfully in the rulings of the courts is without precedent in the past will do well to recall the attitude of Jefferson and Jackson, and especially the outburst of indignation which the Dred Scott decision called forth. As an example of what some look upon as treason to the courts, the contempt with which this decision was regarded has not been duplicated before or since.

The way in which Mr. Lincoln took the Supreme Court to task deserves a passing notice. He did not content himself with maintaining that the decision was bad law. In a speech at Springfield, Illinois, June 17, 1858, he boldly insinuated that Chief Justice Taney, Stephen A. Douglas, James Buchanan and Franklin Pierce conspired together in handing down the Dred Scott decision. After citing the successive points in the alleged conspiracy, he threw his indictment into the following classic:

> We can not absolutely know that all these exact adaptations are the result of preconcert. But when we see a lot of framed timbers, different portions of which we know have been gotten out at different times and places and by different workmen—Stephen, Franklin, Roger and James, for instance—and when we see these timbers joined together, and see they exactly make the frame of a house or a mill, all the tenons and mortices exactly fitting, and all the lengths and propor-

tions of the different pieces exactly adapted to their respective places, and not a piece too many or too few—not omitting even scaffolding—or, if a single piece be lacking, we see the place in the frame exactly fitted and prepared yet to bring such piece in—in such a case, we find it impossible not to believe that Stephen and Franklin and Roger and James all understood one another from the beginning, and all worked upon a common plan or draft drawn up before the first blow was struck.[8]

To this Judge Douglas replied:

It would be perfectly legitimate and proper for Mr. Lincoln, myself, or any other lawyer, to go before the Supreme Court and argue any question that might arise there, taking either side of it, and enforcing it with all our ability, zeal and energy, but when the decision is pronounced, that decision becomes the law of the land, and he, and you, and myself, and every other good citizen, must bow to it, and yield obedience to it. Unless we respect and bow in deference to the final decisions of the highest judicial tribunal in our country, we are driven at once to anarchy, to violence, to mob law, and there is no security left for our property, or our own civil rights. What protects your property but the law, and who expounds the law but the judicial tribunals; and if an appeal is to be taken from the decisions of the Supreme Court of the United States, in all cases where a person does not like the adjudication, to whom is that appeal to be taken? Are we to appeal from the Supreme Court to a county meeting like this?[9]

Douglas also denied the conspiracy charge. Not content with Douglas' denial, Lincoln renewed the charge, and while admitting that he did not "*know*" submitted the evidence upon which he "*believed*" it to be true.[10] Likewise, he objected to "the sacredness that Judge Douglas throws around this decision,"[11] and said:

If I were in Congress, and a vote should come up on a question whether slavery should be prohibited in a new territory, in spite of the Dred Scott decision, I would vote that it should.[12]

He also asked Douglas whether he would acquiesce in a second Dred Scott decision forbidding the free states from excluding slavery from their limits,[13] and stated that Douglas himself had approved of Jackson's refusal to be bound by a Supreme Court decision touching the constitutionality of the United States Bank. He went even farther and asserted that Douglas was once in favor of "adding five new Judges" to the Supreme Court of Illinois in order to reverse a decision of that court, and that "it ended in the judge's sitting down on that very bench as one of the five new judges to break down the four old ones."[14] In short, "Judge Douglas is *for* Supreme Court decisions when he likes and against them when he does not like them."[15]

[8] Debates of Lincoln and Douglas, *op. cit.*, pp. 3–4.
[9] *Ibid.*, p. 32.
[10] *Ibid.*, p. 79.
[11] *Ibid.*, p. 20.
[12] *Ibid.*, p. 20.
[13] *Ibid.*, p. 90.
[14] *Ibid.*, pp. 82–83.
[15] *Ibid.*, p. 62.

Lincoln distinguished sharply between the sense in which he opposed the Dred Scott decision and the sense in which he did not. He disclaimed any intention of resisting the decision in so far as it affected Dred Scott. "We let this property abide by the decision, but we will try to reverse that decision. We will try to put it where Judge Douglas would not object, for he says he will obey it until it is reversed. Somebody has to reverse that decision, since it is made, and we mean to reverse it, and we mean to do it peaceably."[16] Lincoln did not indicate how far he would go to attain his end. Judge Douglas charged him with intending to pack the court.[17] I am not aware that Lincoln ever entered a denial.

The controversy between Lincoln and Douglas in 1858 suggests present-day conditions. The Republican party at its origin was an uprising against those extremists who considered the right to property in slaves paramount to the rights of man. The stand which it took against the Dred Scott decision contributed much to its growth and influence. With its advent to power, however, the party became more and more closely identified with the clandestine work of arranging tariff schedules, getting valuable franchises for a song, looking after the "pork" in river and harbor and public building bills, and with voting the public money for pensions. The leadership of the party suffered the inevitable consequences of long years in power. The moral enthusiasm which attended its origin grew less and less. In striking contrast to 1860, the tendency to emphasize the rights of property and to object to any and all criticisms of court decisions which uphold property rights became more and more pronounced. With Lincoln's arraignment of Douglas for accepting a court decision not at all "on its merits," but because "it is to him a 'Thus saith the Lord,'" the party came to have less and less sympathy. The leadership more and more approximated that of Douglas, who cared not whether slavery was voted up or voted down, and nothing so well describes it as Lincoln's characterization of his distinguished opponent. Said Mr. Lincoln:

> Senator Douglas is of world-wide renown. All the anxious politicians of his party, or who have been of his party for years past, have been looking upon him certainly, at no distant day, to be President of the United States. They have seen in his round, jolly, fruitful face, post-offices, land-offices, marshallships and cabinet appointments, chargeships and foreign missions, bursting and sprouting out in wonderful exuberance, ready to be laid hold of by his greedy hands. . . . On the contrary, nobody has ever expected me to be President. In my poor, lean, lank face, nobody has ever seen that any cabbages were sprouting out.[18]

Happily, in recent years many of the more prominent leaders in the Democratic as well as in the Republican party who answered to this de-

[16] *Ibid.*, p. 20.
[17] *Ibid.*, pp. 33–34.
[18] *Ibid.*, p. 55.

scription have fallen "outside the breastworks." We have been going through a period of political housecleaning, and the politicians in response to an awakened public opinion have been showing fruits meek for repentance. Seldom have the leaders in every party been so much on their good behavior. Judged by the sort of measures that have been placed upon the statute books during the past year, the Democratic party in Ohio and the Republican-Progressive party in California have been about equally progressive. There is not much choice between the Democratic party in New Jersey under the leadership of Woodrow Wilson and the Republican party in Wisconsin under the leadership of Senator La Follette. When politicians in general are competing for the good will and support of the more decent and public-spirited portion of the community, as they are to-day, the friends of good government have much ground for encouragement.

Political parties, in common with individuals, are judged by the kind of company they keep and by the reputations they acquire. This accounts for the defeat of the Republican party and the appearance of the Progressive party in the presidential election of 1912. The Republican party has not been entirely irresponsive to the demands of a more exacting public opinion. A growing number of men truly progressive in spirit has become conspicuous in its counsels. Many salutary measures have been placed upon the statute books under Republican auspices. But in all of this there has been a certain hesitation, a reluctance to move forward save under compulsion, a tendency to death-bed repentance. The revision of the tariff at the hands of the Republican party is a conspicuous illustration. As a result, the party has failed to receive due credit for some of the forward steps which it has occasionally taken. This was especially true under the Taft administration when a number of progressive measures were enacted into law, while others, notably the recommendations of the President on conservation, failed to become laws partly because the public suspected the auspices under which they originated. The Republican party is suffering the consequences of not keeping properly abreast of the times. At a time when new problems were pressing for solution, it has sustained a reputation for "standing pat" and for "letting well enough alone." When it might have invoked the power of the national government to solve problems that are clearly nation wide in character, it has faltered and failed to prove true to the traditions of its origin.[19]

[19] The future of the Republican party is an interesting subject for speculation. On the one hand, it has a great past. Its early devotion to human rights has not been forgotten. It performed a great service in saving the Union and in freeing the slaves. It has repeatedly recognized the sense of nationality which we cherish as a people. Its very name is a household word, and its devotees are still numbered by the millions. Its alliances are by no means as unsavory as those that killed the Whig party, and it has an incomparably greater past. As a going

concern long in the field, it possesses certain substantial advantages which a new party can only painfully acquire. There is a legitimate place for a party that champions the interests of property within reasonable bounds. The differences between the Republican and the Progressive parties on the tariff and the trusts are by no means insuperable.

On the other hand, it is vulnerable in three respects. It distrusts the people, it has not identified itself closely enough with their interests, and it is on too intimate terms with those who participate in politics for private gain, three weaknesses that led to the downfall of the Federalist party. Its future depends on its ability to overcome these weaknesses and on the mistakes of its adversaries. The fact that the Democratic party managed to live down its associations with slavery and its highly questionable record during the Civil War indicates that the future of the Republican party is by no means hopeless. Competition normally leads even a conservative party to make a bid for popular favor, and but for the disposition of many of the Republican leaders to bank upon the mistakes of their opponents rather than upon setting their own house in order, one might confidently predict a field of future usefulness. The party has often profited by such mistakes in the past, but it is always poor strategy to rely upon the shortsightedness of one's opponents for success in any game. Sobered by the responsibility of power, the Democratic leaders may not be as obliging in the future as they have often been in the past, or the Socialist and Progressive parties may profit by their mistakes. If the Democracy rises to the occasion, it may be given a long lease of power. The schism in the Republican party is a more serious matter than many of its leaders realize. Fundamentally, it is not the work of a lot of "soreheads" or of Mr. Roosevelt, but the natural consequence of its own conduct.

ALCOHOL FROM A SCIENTIFIC POINT OF VIEW

II. The Relative Toxicity of the Various Alcohols

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IN a previous study on "The Discovery and Nature of Alcohol,"[1] we have seen that the various alcohols differ among themselves as to their molecular weights and boiling points. These two differences characterizing the alcohols are associated further with a difference in toxicity or poisonous effect. This we shall now consider.

The relation between the molecular weight of a substance and its toxicity was seen as early as 1837 by Black, but it was not until more than a quarter of a century later that Rabuteau was able to generalize this relationship. In his study of the metals he observed that the higher the molecular weight and boiling point, the greater the toxicity. This law experiment has shown often to be in default for the metals. For the alcohols, on the other hand, it has a striking application.

If greater toxicity be associated with a higher molecular weight and boiling point, it would follow that an alcohol such as amyl, with 88 atoms to the molecule and a boiling point of 138° C., would be more poisonous than ethyl alcohol with 46 atoms to the molecule and a boiling point of 78.4° C. Such, in fact, was early shown to be the case. But it may be objected that the difference between the two is extreme. It would be more convincing if two alcohols, such, for example, as ethyl and methyl, closely approximating in molecular weights and boiling points, complied with the law.

To a comparison of these we shall return.

We shall first consider the experimental evidence which has given to us a measure of the exact toxicity of the various alcohols.

Early Experiments on the Toxicity of Alcohol

Fr. Petit, who was among the first to busy himself with the study of the toxic effects of alcohol, showed that if alcohol is injected into the veins of an animal, a rapid death ensues. Following this simple experiment a considerable period of time elapsed before the subject was again taken up. The next work recorded is that by two Italian physiologists, Lussana and Albertoni.

These investigators, by a series of interesting experiments, esti-

[1] Pop. Sci. Mo., p. 567, June, 1913.

mated that 6 grams of pure alcohol for each kilogram of body weight is a lethal or killing amount when injected into the stomach of an animal.

This was the beginning of quantitative work to which a few years later Dujardin-Beaumetz and Audigé added a brilliant series of experiments. They studied not only the toxicity of ethyl alcohol, but also that of other alcohols as well. Briefly stated, the question that they proposed to themselves was: How much alcohol is necessary to kill a kilogram of living matter in *less than thirty-six hours?*

If, for example, in studying the toxicity of alcohol, we find that 77.5 grams of alcohol injected into the stomach of an animal of 10 kilograms weight produces death *in less than 36 hours,* the question then as to the amount necessary to kill per kilogram is easily determined, for if 77.5 grams kill the entire 10 kilograms, 7.75 grams is the amount necessary to kill per kilogram. This, in fact, was the amount of ethyl alcohol found by them to be the lethal dose. This amount, however, is considerably below the estimate of 6 grams by Lussana and Albertoni. This difference in amount may be explained in part by the difference in the time limit employed; for while 6 grams may eventually kill, 7.75 grams is necessary to kill within a limited period of thirty-six hours.

For the coefficient of toxicity of the *higher alcohols,* Dujardin-Beaumetz and Audigé found the following values: For propyl, the member of the series just above ethyl, 3.75 grams per kilogram; for butyl 1.85, and for amyl 1.50 to 1.60 grams per kilogram body weight.

The molecular weight, boiling point and relative toxicity of the alcohols of fermentation are briefly summarized in the following table:

Alcohol	Molecular Weight	Boiling Point[2]	Relative Toxicity
Ethyl	46	78.4° C.	7.75 gr. per kg.
Propyl	60	97.0° C.	3.75 gr. per kg.
Butyl	74	117.0° C.	1.85 gr. per kg.
Amyl	88	138.0° C.	1.50 to 1.60 gr. per kg.

From this table it is to be seen that the higher the molecular weight and boiling point, the smaller is the amount required to kill a kilogram of living matter. In other words, the higher an alcohol is in molecular weight and boiling point, the greater is its toxicity. This, as we have seen, is the law of Rabuteau with which the above facts of experiment are in direct accord.

In a study of methyl alcohol, on the other hand, Dujardin-Beaumetz and Audigé concluded that the toxicity is not in keeping with the law of Rabuteau. Though methyl alcohol has a molecular weight of 32 and a point of ebullition of about 66° C.—in both lower than ethyl alcohol—yet its toxicity was found by them to be greater—7 grams

[2] The boiling points are taken from Meyer and Jacobson's "Lehrbuch der organischen Chemie," Bd. I., 1906, p. 209.

being sufficient to produce death per kilogram, while, as we have seen, 7.75 grams of ethyl alcohol were required.

But the methyl alcohol of the time of Dujardin-Beaumetz and Audigé, as we now know, was far from pure—hence the failure to gain an accurate measure of its toxicity. To-day that methyl alcohol is produced in greater purity, we should be able to retest the question with greater accuracy. To this we shall soon return.

From the investigations of Dujardin-Beaumetz and Audigé we have, then, our first experimental evidence that while alcohols in large doses are poisonous, not all alcohols are equally poisonous. To them is also due the credit of showing that for the alcohols of fermentation the toxicity is directly in proportion to the molecular weight and boiling point; in other words, that they are in accord with the law of Rabuteau —the higher the molecular weight and boiling point, the greater the toxicity.

Difficulties Confronting Investigation of Toxicity

Concerning the difficulties confronting investigation in this subject, we have said nothing. Some of these we shall now consider.

Observation has been made by various investigators that different animals react differently to poisonous substances. From this observation arose the discussion as to "the choice of animal" best suited to a study of alcoholic poisoning. Morgan, who had experimented upon the dog, argued that it was the most acceptable animal for work of this sort. Laborde, who, on the other hand, had studied the guinea-pig, urged the use of this animal; while Colin (who had studied neither) was of the impression that the horse or the cow would be more susceptible than either. Daremburg, in considering the discussion, hopefully suggested that probably another contradictor would recommend either the giraffe or the elephant. This in fact might have been the plight had not the work of Joffroy and Serveaux appeared.

Joffroy and Serveaux have shown that while animals differ in susceptibility according to their kind, this difference is relatively constant and usually but slight. The choice of animals thus becomes, in great part, important in so far as one animal rather than another serves better the purpose of this or that investigator.

A question of more than passing importance in the measure of toxicity, however, is the method of administering the substance to be tested. It is a well-known fact that some substances which are extremely poisonous when injected under the skin, for example, snake venom, are in no sense poisonous when given by the stomach. On the other hand, other substances which show slight poisonous effects if given subcutaneously, act with extreme rapidity if added directly to the blood stream. These facts give to the ways and means of injection a high importance.

The difficulties in the way of injection may now be considered more fully. A lethal dose of alcohol injected into the stomach or under the skin of an animal becomes lethal only after it has been absorbed into and distributed by the blood stream. Hence the importance of knowing whether the alcohol is absorbed promptly so as not to undergo loss or change in the tissues. In a word the rate of absorption must be rapid.

If also by injecting a lethal amount of alcohol under the skin or into the muscles, serious secondary injuries, such, for example, as abscesses and the like, result, a source of error is possible; for a dose of alcohol under the toxic equivalent aided by these secondary influences might thus produce death.

It was evident to Joffroy and Serveaux that in order to prevent errors arising from the rate of absorption and to reduce to lowest terms the danger of secondary injuries, a method should be employed which would insure that the entire amount of alcohol be in the blood at the same time. This could be accomplished in only one way, that was by adding the alcohol directly to the blood stream. They therefore turned their attention to *intravenous* injections.

While this method of adding the alcohol directly to the blood stream would control the rate of absorption and largely allay secondary injuries, yet it was found productive of errors the overcoming of which was imperative to an accurate measure of toxicity. In the first place it has been shown that if alcohol be injected too rapidly injuries both to the veins and to the viscera arise. On the other hand, if it be added too slowly, a loss of alcohol may occur through the kidneys and other ways of elimination.

The first problem of Joffroy and Serveaux was to find a way by which the injection could be made at constant pressure. This was accomplished by substituting for the hypodermic syringe which had been generally used the "flaçon de Mariotte." This gave a constant pressure which was easily regulated at any time during the experiment. By injecting one cubic centimeter per minute for each kilogram of body weight they found no injury occurring either to the veins or to the viscera. With this rate it was also found that the entire amount could be injected before any considerable time had elapsed for elimination to take place.

With the error of rate of injection thus controlled they were ready to try the measure of toxicity. A series on rabbits gave discouraging extremes varying from 4.32 to 12.18 cubic centimeters per kilogram necessary to kill.[3] With variations so great as nearly 3 to 1 it was evident

[3] The exact amounts were as follows: 4.32 c.c., 8.92, 7.26, 12.18, 6.35, 8.44, 4.90, 7.54 c.c. per kilogram.

that the method was far from perfect. What in the method caused so great a variation?

An examination of animals that had died from small amounts demonstrated that death had been due to coagulation and to a consequent blocking of the blood stream. They then set about for a solution of the more serious problem—the prevention of coagulation. First, tests with various salts were made. But these were found to be of no service since a salt in order to be a non-coagulant had to be of sufficient strength itself to be toxic.

A second study hit upon an ingenious method of procedure. It has long been known that the blood of animals ingested by leeches is prevented from coagulation (in the body of the leech) by an anticoagulant. Haycroft demonstrated that an alcoholic extract of the buccal cavity of leeches injected into the arteries of rabbits or dogs prevents coagulation of the blood, and at the same time is productive of no observable injury. Joffroy and Serveaux determined upon testing its powers to prevent coagulation in a normal salt solution.

It is evident that the addition of so complex a substance as leech-extract to the blood of an animal must be made only with the most careful control. Two things were demanded of it: (1) It must serve its purpose, in this case prevent coagulation; (2) it must in no way injure the animal. In testing for its injurious effects it was found that the injection of enormous quantities[4] produced no injury. Since no coagulation followed they were in possession of an anticoagulant by the aid of which they could test the toxicity of a substance added directly to the blood stream.

Later Experiments and Units of Measure

(a) The Experimental Toxic Equivalent

Joffroy and Serveaux established as a convenient unit of measure the amount of alcohol that would kill per kilogram while the experiment was in progress. This they called the *experimental toxic equivalent.* This limit, as is evident, has the advantage of greater rapidity than that (36 hours) used by Dujardin-Beaumetz and Audigé. By injecting the alcohol and this anticoagulant into the blood, in a series of eight experiments, the following amounts of alcohol were found sufficient to kill per kilogram of body weight: 12.65 c.c., 12.18, 11.69, 10.32, 10.51, 11.99, 12.48, 11.70. This series shows a striking regularity with extremes varying only between 10.32 and 12.65 c.c., variations which would be readily accounted for by differences in age, race and the like of the rabbits used.

For ethyl alcohol, then, these authors have demonstrated that 11.69

[4] 1,185 c.c.—nearly 600 grams per kilogram—was injected; of this some was lost, but 425 grams per kilogram remained.

c.c. (9.36 gr.) is the amount sufficient to produce death during the operation, that is, it is the experimental toxic equivalent.

For methyl alcohol, which Dujardin-Beaumetz and Audigé had found more toxic than ethyl, the results of Joffroy and Serveaux are most interesting. Although the method of purification had been greatly improved since the time of Dujardin-Beaumetz and Audigé, yet methyl alcohols coming from different sources were still shown to vary in their poisonous effects. Thus three alcohols from different sources gave the coefficient of toxicity for the rabbit as follows:

23.75 c.c. per kg.
26.75 c.c. per kg.
25.55 c.c. per kg.

As an average of these three series we have an *experimental toxic equivalent* of 25.35 c.c. for methyl alcohol. The point of interest is not the degree of variation present, but the relatively slight toxicity of methyl alcohol when compared with ethyl alcohol. We shall see that the same is true when we study this as measured by another toxic limit.

For the entire series of primary alcohols which we have considered—methyl, ethyl and the higher alcohols—the following table summarizes the experimental toxic equivalent and its relation to molecular weight and boiling point.

	Chemical Formula	Molecular Weight	Boiling Point	Expt. Toxic Equivalent
Methyl.....	(CH_3OH)	32	66.0° C.	25.35 c.c.
Ethyl.....	(C_2H_5OH)	46	78.4° C.	11.70 c.c.
Propyl.....	(C_3H_7OH)	60	97.0° C.	3.40 c.c.
(Iso)-Butyl.....	(C_4H_9OH)	74	117.0° C.	1.45 c.c.
Amyl.....	($C_5H_{11}OH$)	88	138.0° C.	0.36 c.c.

Such are the results when death is produced while the experiment is in progress. While this method has the advantage of rapidity it has also disadvantages.

It is clear that by adding alcohol up until the last inspiration more alcohol is given than is necessary to produce death. For this reason Joffroy and Serveaux realized that the experimental toxic equivalent has only a comparative value. For the exact measurement of toxicity the question is not how much alcohol will kill while the experiment is in progress, nor yet within a limit of 36 hours. The one question is, What is the amount necessary to kill?

(b) The True Toxic Equivalent

The amount necessary to kill may be determined in one of two ways: (1) By giving for a long period of time small amounts which will finally produce death, or (2) by giving at one time an amount sufficient to pro-

duce death within a brief delay. The second method was selected for experimentation. This amount was designated the *true toxic equivalent.*

By experiment it was found that for the dog when an amount less than 7.90 c.c. of commercially pure ethyl alcohol was given recovery followed, at or above 8 c.c. per kilogram death ensued. For the dog, hence, the true toxic equivalent was set as 7.95 c.c. (6.36 gr.). For the rabbit from amounts lower than 7.50 c.c. all survived; from amounts above 7.80 c.c. all died. For the rabbit, therefore, 7.75 c.c. (6.20 gr.) per kilogram was set as the true toxic equivalent. The average of 6.36 gr. for the dog, while seemingly differing considerably from that (7.75 gr.) found by Dujardin-Beaumetz and Audigé is in fact in close accord with it.

If in the experiments of Dujardin-Beaumetz and Audigé all animals that died within three or four days are substituted for all animals that died within 36 hours, the toxic equivalent for ethyl alcohol instead of being 7.75 gr. increases to about 6 gr. per kilogram. This is in agreement with what Lussana and Albertoni found, but it is slightly higher than that given by Joffroy and Serveaux (6.36 gr.) in the perfected method.

The work by Joffroy and Serveaux on the *true toxic equivalent* of methyl alcohol is most thorough. By the same procedure as for ethyl alcohol they have shown that for the dog amounts above 9.10 c.c. produce death. They have, therefore, established as the true toxic equivalent for the dog by intravenous injection 9 c.c. per kilogram. For the rabbit this is 10.90 c.c. per kilogram.

Two things of interest are made evident in the work on methyl alcohol. These are: (1) That for the dog methyl alcohol is more toxic than for the rabbit (the opposite was seen to be true for ethyl); (2) that for both the dog and the rabbit it is less toxic than ethyl alcohol, and is therefore in harmony with the law of Rabuteau.

From these various studies it is clear that alcohol in large quantities is a poison capable of causing death, the most toxic being amyl and the least toxic[5] methyl, and that the difference in the degree of toxicity follows the law of Rabuteau: A substance (alcohol) is as toxic as its molecular weight and boiling point are elevated.

[5] This does not take into account the latent ill-effects on man shown to be characteristic of methyl alcohol.

THE MOST REMARKABLE MONUMENT IN WESTERN CHINA

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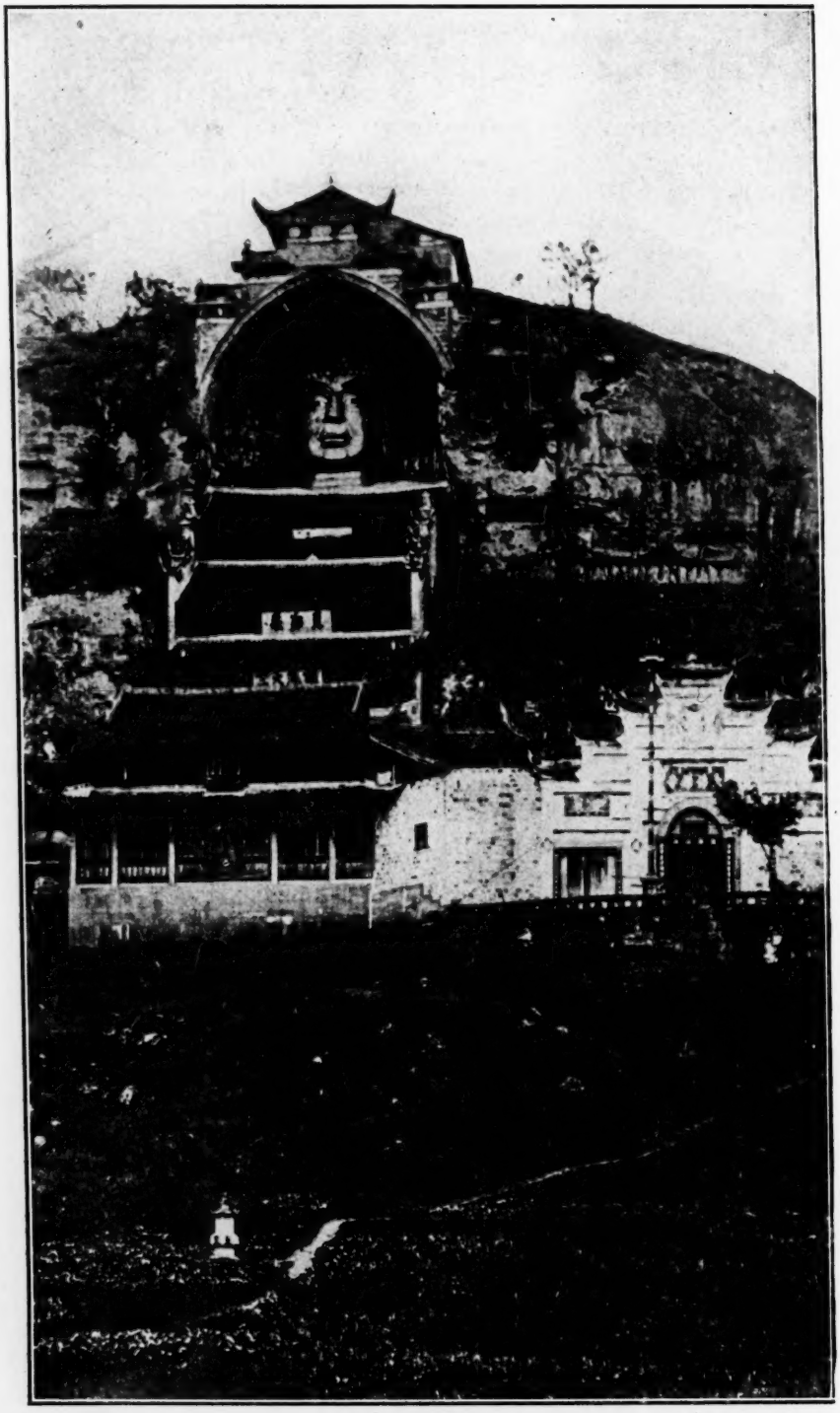
IMAGINE, if you please, a low river bluff—thirty or forty feet high—faced with a masonry of red sandstone and crowned with warlike battlements, beyond which rise the tiled roofs of low-built houses and fantastic outlines of quaint old temples. Such is the picture presented to the traveler who visits the city of Jah-ding in western China. Behind those battlements are huddled the homes and shops and public buildings of a densely packed population, among whom many a quaint and curious custom still obtains, for modern civilization is being introduced but slowly.

Far in the interior of Asia, more than a thousand miles from the sea as the crow flies, that city is located. It stands on the banks of a gently flowing river. The dark red walls overlook the dull gray water, while overhead hangs a dull gray sky, since the province of Four Streams is renowned throughout all China as the land of clouds. Many travelers have visited that city, for the river which washes its walls is one of the principal waterways of western China. In fact, it is one of the headwaters of the Yangtze-kiang, the natural outlet of that country. To be precise, the town is located at the confluence of three streams, one of which comes from the capital of the province, the great city of Chentu. That capital is the goal of many a globe-trotter of adventurous disposition or scientific tendencies—the kind who write books. On leaving it he floats down stream in a native boat for twenty-four hours and ties up at the gates of Jah-ding (spelled Kiating on the maps), to make a visit to Mt. Omei, one day's journey to the west. That mountain is not only one of the natural wonders of the world, but is also a center of pilgrimage for all the Buddhists of China, as it marks the point where Buddhism first entered the country. Dotted with temples from base to summit, the mountain overtops the surrounding plain by nearly two miles, while on one of its faces a tremendous precipice descends almost unbroken for six thousand feet. It attracts the adventurous globe-trotter with an irresistible magnetism.

But it is not the writer's purpose to deal with Mt. Omei or any of its features. They have been portrayed in detail by others. The object of this account is to describe a curious relic, not far from Jah-ding, which well might attract the traveler's attention, but which has received scant notice. Permit me first to outline how travelers, one after another—men of literary and scientific attainments—journeyed in far western China, wrote of its scenery and its monuments, but neglected to visit and describe the most remarkable monument of them all.

In the late 70's, Colborne Baber, British traveler, drifted down the



THE GREAT BUDDHA AT YONG-HIEN IN WESTERN CHINA. Mentioned, but not visited by the Count d'Ollone. See p. 196 of "In Forbidden China."

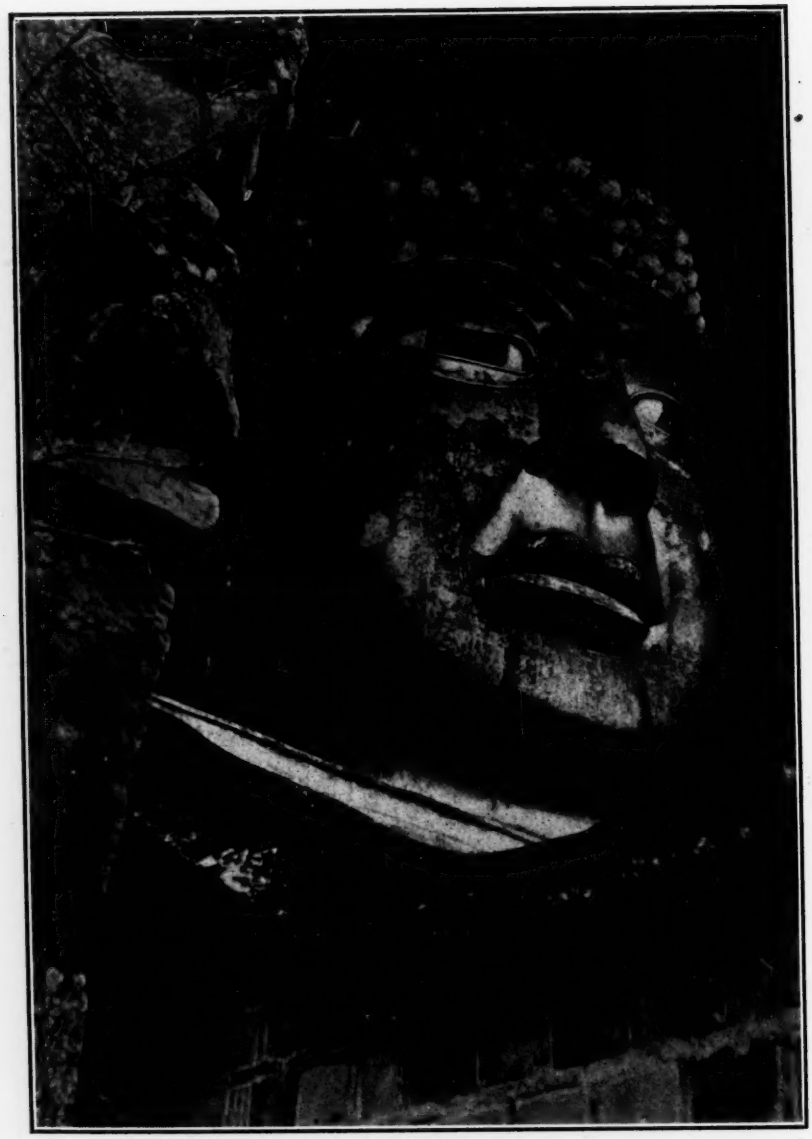
river Min and moored his boat at the gates of Jah-ding. Leaving the stream, he ascended Mt. Omei, and the resulting account, which he published in England, provoked the curiosity of the traveling and scientific world, for it was the first to call attention to that strange old mountain, with its clustering monasteries and temples, its noble bronzes, and its glorious natural scenery. But Baber found other wonders besides those of Omei which were worth recording. A few hundred yards from Jah-ding stands the ruin of an immense image of Buddha. Twelve hundred years ago, a niche two hundred feet high was cut in a cliff which stands by the side of the river. The recess extended the full height of the cliff, and in it was carved an immense image. Unprotected from the elements, and neglected by the people, time has done its work; practically all that is left consists of a few vestiges of the face. The entire niche is overgrown with brush; vegetation hangs from the features so as to give it the appearance of possessing eyebrows and mustache. Standing on the opposite bank, it is possible dimly to discern the outlines of a countenance; that is all.

Baber freely admitted that this old image is a ruin and a disappointment. He also admitted having been informed through a Russian traveler that a hill, two days' travel east of Jah-ding, had been hewn into a representation of the seated form of Buddha "several hundred feet high, which far overtops the roofs of surrounding temples." Here, it would seem, was something worth the effort to visit and describe, yet he made no attempt to do so.

About ten years later (1887), Virgil Hart, American missionary, followed in Baber's footsteps and duplicated his journey, collecting as he went the material for one of the most vivid, accurate and delightful books of travel that have ever treated of China. The volume which he published challenged attention and provoked admiration. Hart's flowing phrases were in striking contrast to the baldness and bareness of Baber's account. The reverend gentleman treated Mt. Omei with especial fulness and enthusiasm. He said:

> Mt. Omei is a center of natural and *artificial* wonders, the like of which may not be found elsewhere upon the globe. I speak advisedly. The world is large, and in regions like Switzerland and Alaska, nature seemingly has been taxed to the uttermost to produce a combination of natural objects of surpassing beauty and grandeur. Here, however, near the borders of Chinese civilization, we find a region of unequaled sublimity—a combination of lofty mountains, of swift rivers and of valleys of wondrous fertility. Then also of the works of man there are many—such as thousands of brine-wells, a great silk culture, a white wax industry, mountains chiseled into the forms of idols, colossal bronze statues, pagodas, and one temple wholly of rich bronze. Great Omei Mountain is scores of miles in circumference, rising 11,000 feet, its highest point enveloped in the everlasting clouds. All these wonders are within a radius of forty miles.

On another page, Hart quoted Baber's account of the figure sculptured in the river bluff above Jah-ding, and added (p. 176):



THE FACE OF THE GREAT BUDDHA AT YONG-HIEN. The features had been covered with gilding, which is peeling off, but is best preserved on the upper lip.

One would suppose Buddhist ambition to be satisfied with an undertaking of this magnitude, but we are told by a Russian traveler that it is a mere infant beside one a few days' journey distant. There he found a mountain—a small one, of course—fashioned by the hand of man into the form of Buddha.

Yet it does not appear from Hart's narrative that he made any attempt to visit and describe so remarkable a wonder.

In 1892, Archibald Little, English merchant, explorer and author, driven out of Chungking by the cholera epidemic, arrived at Jah-ding on his way to Mt. Omei, where he spent several weeks, afterwards embodying his experiences in a book, "Mt. Omei and Beyond." He made no attempt to locate the Russian traveler's find, although his wife secured an excellent photograph of the image on the river bank.

In 1906, R. F. Johnston, while collecting material for his work, "From Peking to Mandalay," arrived at Jah-ding, ascended Mt. Omei, and described its temples and antiquities in the most thorough guide-book style. Yet he seems never to have thought of seeking out the Russian traveler's great Buddha.

Early in 1908, the Count d'Ollone traveled in the same region. His experiences have appeared in a recent volume, "In Forbidden China," so called because most of his time was spent among the savage and independent Lolos. On page 188 of that volume, he says:

Kiating possesses one of the most astonishing, though not the most admirable, works of art ever produced by human hands. In a cliff overhanging the confluence of the Yah, the Ta-Tu-Ho and the Min, there is a Buddha, cut out of the solid rock, no less than one hundred and eighty feet in height. It is by far the largest statue in the world. It occupies a recess some sixty feet in width and depth. The god is represented sitting in European fashion.

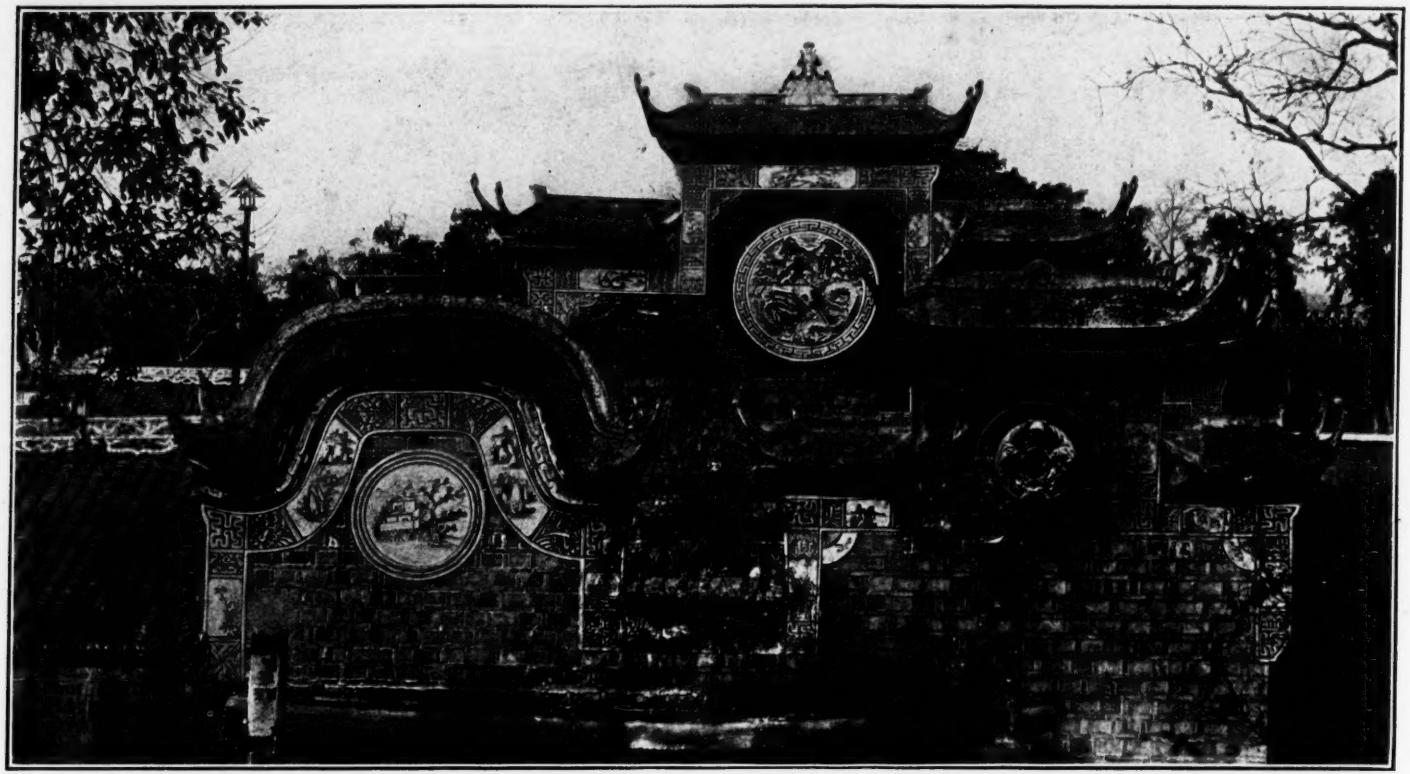
It must be confessed, however, that this great statue is no longer effective. Under the action of the weather, the contours are worn and crumbling; great blocks have fallen away, and the vegetation—mosses, bushes and even trees—has attacked and is disfiguring what remains. Without being able to see how Colborne Baber failed to discover, except in the face, any trace of the sculptor's hand, we must admit no traces of actual art are now visible. It looks as though the hewers of stone had roughed out of the rock a rudimentary statue, like a snow man, which the artist never completed.

On the next page he goes on to describe the search for rock sculptures which his party conducted in the grottoes surrounding the city, where they had the good fortune to discover a group some miles to the north. On page 193 we find the statement:

Our unexpected discovery, that of rock sculpture of great antiquity and pertaining to a vanished art, filled us with delight, for it revealed a past which was practically unknown. The reader may imagine that we were always on the alert for anything that might put us on the track of fresh discoveries, but I must own that the results were constantly negative.

He then tells how his party was put on several false trails, but finally learned (p. 196) that there was a

very fine Buddha at Yong-hien, some fifty miles to the southeast. Yong-hien was too far from our route, and we had no intention of going in search of its Colossus. No doubt, had we gone, we should have been directed to another.



DETAIL OF CHINESE TEMPLE ARCHITECTURE AT ONE END OF A TEMPLE IN YONG-HIEN, THE CITY BELOW THE GREAT BUDDHA. Notice two chimneys in the foreground, which disprove the statement that "in China proper chimneys are unknown."

This was the Buddha of whose rumored existence Baber and Hart had already made mention.

Thus I have outlined all that had been printed in English regarding this mysterious marvel. Travelers, of the book-writing sort, had ignored it or passed it by. Not one of them had the initiative to go fifty miles off the beaten track in order to picture and describe the most remarkable monument in that part of the world.

Early in 1910, the writer of this account visited Jah-ding and—although not anxious to pose as one "alert for anything that might put him on the track of fresh discoveries"—decided to do what the writers of books—Baber, Hart, Little, Johnston, d'Ollone—had neglected; to travel two days' journey to the east in order to definitely locate and describe the rumored marvel.

It was a narrow winding road which led across the hills and through the valleys, zig-zagging hither and yon. The customary method of travel in that region is by sedan chair, but, owing to the fact that the season was the Chinese New Year, it was almost impossible to obtain chair carriers; most of the distance had to be walked. Were I writing a story, it might be made entertaining by an account of wayside scenes and daily incidents of travel. I might describe the farmhouses with their low tiled roofs and their hedges of bamboo, the bridges built of massive masonry; the stone portals spanning the way to commemorate by their scriptions virtuous or useful lives, the tall pagoda rising from its hilltop in the distance to signalize the presence of a city. As this is not a story, let us hasten to the end of the fifty miles, and view the Great Buddha. At the end of two days of travel, we saw before us the colossal image in all its dignity; not nearly so large as rumor had made it out, but a Colossus still. Of course, the story of the whole hill having been hewn into a figure was a fabrication. The figure is on the same plan as the one on the river bank at Jah-ding. The upper half of the hill-side consists of a sandstone cliff, and in this a niche fifty feet broad had been cut, leaving a central core of stone, which was then carved into a figure seated in European style, not cross-legged as Buddha is so often represented. The writer measured the breadth of the opening; using that as a unit of measurement on the photograph, the height of the image is not less than one hundred feet, that of the hill not less than two hundred. As the camera was pointing upward at a small angle, the vertical distances must be greater than the figures given.

The reader will observe by glancing at the picture that a series of five tiled roofs, descending like a flight of steps, have been built before the image to protect it from the weather, so that only the face can be seen from without. But by going within, the location of the feet can be determined; they are on a level with the space between the two lowest roofs. A white-fronted structure may be seen below and to the right; it is a temple, and another temple crowns the height. As the writer

and his men came in sight of the Great Buddha, we paused and rested from our journey at a point near one of the gates to the walled city which lies in the valley below. As our eyes turned to the great face, which has been gilded until it shines like metal, as the immense size and

A WONDERFUL PAGODA, WITH TILED ROOFS, IN WESTERN CHINA.

perfect preservation of the idol made their impression, the thought that came to my mind was, "How far more marvelous is this than many of the world's boasted wonders." I thought of the Colossi at Thebes and the Sphinx. What are they? Scarred, ruined and defaced by the hand of man and the effects of time, they are scarcely recognizable as images. They are little better than lumps of battered rock. But far in the west of China sits this old Buddha, remote from the tracks of travel, unnoticed and almost unknown; yet greater in size than the Egyptian

Colossi, his proportions preserved in all their pristine freshness, temples above and below him, and priests in attendance to keep the incense burning at his feet. There he sits, grimly gazing out over the tiled roofs of the city which lies before him.

A Stone Portal Spanning a Road in Far-western China. This specimen was erected in 1906.

While exploring the temple, I asked one of the priests the age of the image. His answer came, "Gee chien nien. Some thousands of years." I give it for what it is worth.

Another thought which that monument inspired was in reference to a passage in one of Conan Doyle's delightful stories, which describes a party of tourists viewing one of the ancient temples of Upper Egypt. The author makes one of the characters say:

If one could come wandering here alone—stumble upon it by chance, as it were—and find oneself in absolute solitude in the dim light of the temple, with these grotesque figures all around, it would be perfectly overwhelming. A man would be prostrated with wonder and awe. But when Belmont is puffing his bull-dog pipe, and Stuart is wheezing, and Miss Sadie Adams is laughing—and that jay of a dragoman speaking his piece.

My thought was that, if such are Conan Doyle's preferences, he would enjoy a visit to the place before which I stood. The visitor would ascend to a broad stone platform that lies before the white front of the temple. He would enter a dimly lighted interior, where priests are tapping the drum and raising their rude chants before grotesque carven images of the types so common in China. Turning, the visitor would ascend to a platform built before the feet of the Colossus, below which he could stand and gaze with head thrown back at the giant bulk above him. There would be no danger of his being disturbed by the idle chatter and empty laughter of gaping tourists, for I have already intimated how scarce travelers are in that portion of the world. It would be as though time had rolled back twenty centuries and he stood in one of the temples of ancient Egypt.

To get a nearer view of the face of the Buddha, it would be necessary to circle the hill and ascend one of two trails which lead around the front of the cliff. Along these trails, life-size figures have been carved in the face of the sandstone. They are in a very ruinous condition and are only remarkable because of their belonging to the ancient Greek type of sculpture, so different from the modern Chinese type. They resemble the rock sculptures photographed and described by the Count d'Ollone (p. 196). Above the end of either trail a tablet containing a long Chinese inscription has been carved in the solid rock. No doubt these inscriptions contain much interesting information concerning the great Buddha, but the writer's limited knowledge of the language prevented him from deciphering them.

As we come to the end of this account it would be entirely reasonable for the reader to inquire why the missionaries—of whom there are many in western China—have not written any account of this image, if it is "the most remarkable monument in that part of the world." The missionary attitude toward such objects may be explained most easily by reference to a trifling incident in my own experience. On my arrival in western China, I met an American cleric who had been stationed in a very out-of-the-way corner of that country. Eagerly I asked him to tell me some of his experiences. What sort of a life had he and his family led? "Oh, Mr. Sprague," he said, "it was just like life anywhere else." From his point of view the answer was correct. For him, life did not extend one inch beyond the end of his nose. His interest in the external universe was nil. So it is, as a rule, with the missionary. Absorbed in his books, his family and his congregation, the world around him escapes his notice.

THE PLACE OF STUDY IN THE COLLEGE CURRICULUM

BY DR. P. H. CHURCHMAN
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IF some acute and unconventional enquirer should raise the question whether the governing ideal of the American college is and ought to be severely intellectual, the man who takes things at their face value would experience a shock. He has never supposed that any other sort of ideal was conceivable. Look at the catalogues; do they not give sufficient evidence of a passionate interest in things intellectual by their whole-hearted devotion to courses and honors, to admission and graduation, to fellows and faculties? Such a theory may perhaps be pardoned in one who is on the outside, but a bowing acquaintance with the realities would suffice to show that this opinion held by our trustful friend simply proves that he has not investigated the facts;[1] for, if he cared to take up such an investigation, scores of college teachers could provide him with interesting evidence indicating what many students, alumni and parents, and even some faculty members, really think about this matter. As the first exhibit in their case against the great academic illusion, critics might present a vigorous article on the subject of college "cutting," recently published in the *Harvard Graduates' Magazine*[2] by Dean Hurlburt, for therein the writer incidentally pays his respects to the intellectual ambitions of some students and parents whom it has been his rare good fortune to know. He cites one especially interesting case—that of a father whose son, in spite of notable success in athletics, had been dropped from college. This father was a college graduate, but the educational conception of the college does not seem to have troubled him greatly, and he appears to have been perfectly

[1] If any reader should feel that the position of this article is extreme, he is invited to read President William T. Foster's able book on "The Administration of the College Curriculum" (Houghton, Mifflin, 1911), Part II., *passim*. There he will find views no less radical—to say the least—than those defended in these pages, and he will also be supplied with a detail of argument and some scientifically marshalled evidence that are impossible in a brief article. President Foster's conclusions frequently agree strikingly with those of the present writer, but the fact that his book was not read until after this article was practically completed is sufficient proof that most of these coincidences are undesigned. Some of my contentions, however, have been considerably revised after reading his book, which, for this reason, and for the purpose of presenting the other accidental confirmations of my arguments, has been freely quoted in the notes.

[2] March, 1911, pp. 400 sq.

satisfied to have his son ignore it also. "My son's college life," said he to the dean, "has been just what I wanted it to be; of course," he conceded as an afterthought, "I wish that he had won his promotion." One case of that kind may not be conclusive, but some who know the college world are convinced that the instance is typical—that the conception of college life which subordinates study to athletics or to social success (or else ignores it altogether) is limited to no single group of individuals and to no one institution, that it seems to be the honest ambition of an appalling proportion of fathers and mothers who are sending their sons to fashionable colleges, in the same spirit that accompanies their daughters to fashionable finishing schools.

After hearing the testimony of parents, our investigator may do well to learn also how some alumni feel about college work. Let him listen, for instance, to an intelligent young physician who received the bachelor's degree from Princeton seventeen years ago, and who puts his ideal of a college career in somewhat this fashion: "Don't talk to me about making students work harder; work in itself is not only useless, it is degrading. There is but one thing of value to be got from college courses, and that is the ability to cram hastily into one's head a few essential facts, which comes from the passing of examinations. No man ought to be compelled to work hard and steadily at anything that does not interest him. You remember X; he was a grind in college and graduated near the head of the class but missed a lot of fun; Y, on the other hand, finished about as near the bottom of the class, but had a royal good time. Did it do the grind any good to work so hard? Both men are in medicine; is the loafer any the worse for his loafing?" We do not stop now to question data nor to analyze fallacies;[3] we merely note in passing that this feeling appears to be shared—though, perhaps,

[3] "Only one man in twelve years whose college record fell below C has contrived to change his habits sufficiently to graduate with honor from the [Harvard] Law School. . . . The same general truth holds for students in the Medical School. . . . These facts are quite at variance with popular opinion. Returns from several hundred Harvard undergraduates express the prevailing idea that success in college scholarship furnishes little or no indication of those intellectual qualities that men desire to possess. 'College life' is said to be the thing. The notion has spread that 'sports' in college settle down in the professional schools and surpass the men who in college were 'grinds.' Pity is often expressed for the unfortunate salutatorians and valedictorians who are supposed to be doomed to failure in life. Such notions must now go the way of many others, though some men will still comfort their mediocre college work by exalting opinions above facts. There are still people who believe that the earth is flat." W. T. Foster, *op. cit.*, pp. 230–232. See further President A. Lawrence Lowell's analysis of some interesting evidence along this line in *The Educational Review* of October, 1911 ("College Studies and Professional Training"). Possibly these facts will come as news to a good many of us who used to share the Harvard undergraduate's illusion in regard to the capabilities of "sports" and "grinds."

in less radical form—by hundreds of graduates who are men of reputable standing, and some of whom may be sending sons of their own to college. Talk to such graduates of loyalty to *alma mater*, and it will express itself in terms of getting money, recruiting students (especially athletes), coming back to reunions, putting up buildings and supporting the team; the educational aspect of the college is a negligible aspect—a subsidiary nuisance. In a gathering of "loyal" alumni of this stripe the man who would argue for even an approximation to the scholarly ideal is actually put upon the defensive—if he is not an object of derision.

If it be true that a great deal of parental and graduate opinion is openly hostile to the strenuous view of college work, no surprise should be excited by the discovery that the undergraduate atmosphere also is polluted;[4] nor that the school-boy has either already caught the disease before leaving school, or soon contracts it in the unhealthy atmosphere of the college. Hence, unless one be wholly in error in one's pessimistic verdict upon present conditions, it turns out to be less ridiculous than it may have seemed at first blush to ask whether the highest place in college is being given to severe intellectual discipline; the mere possibility that the situation is grave should arouse all serious educators, and the veriest honesty demands a frank answer to the enquiry from all responsible for the conditions.

The answer to be expected from some parents and alumni, as we have seen, would be that intellectual considerations are altogether secondary, and that the important business of the college is not study. Probably very few college professors and presidents would care to take their stand with these enemies of the intellectual; but certainly many such academic gentlemen would have to be ranked, with or without their own consent, among the compromisers. They may not explicitly condone loafing, but they preach that

> 'Tis better to have come and loafed
> Than never to have come at all;

they may not disparage intellectual attainment, but they are unwilling to demand it of all of their students. The attractive creed of such educators might be formulated somewhat as follows: "College is a place of large opportunities, among which the purely intellectual are not necessarily the greatest. We should, of course, aim to develop and instruct the minds of our students, but we must not forget that one of the greatest educational forces in college is the life itself, and it is by no means incumbent upon us to insist that all of those in residence shall

[4] At a recent conference of educators the following motto, which had been found hanging upon the wall of a student's room, was produced: "There is just this advantage about study, that it shows by contrast the value of those things for which we really come to college."

be real students." This is the view which—possibly unjustly—we are apt to associate with the typical Oxonian frame of mind; and it is by no means wholly indefensible, especially when contrasted with its Continental opposite of young pedants who, in spite of much learning, may be arrant fools.

It is to be feared, however, that some of the commonest reasons for loose dealing with idle students are not particularly creditable. The least deplorable, perhaps, is an uncritical good nature, weakly consenting to allow the deficient student to continue his life of delightful indolence, and cheerfully indifferent to the effect of leniency upon the delinquent and his fellows. Perhaps, too, this attitude is not always easy to distinguish from lack of courage in those for whom popularity is the first great test of professional success. Now popularity, honestly won, is among the most precious things in the world. When coupled with just severity it is an ideal attribute in the college professor. But popularity in the man who is also notorious for "snap" courses, or who is always "on the side of the students" in matters disciplinary and scholastic—on the side of the undesirable students, that is to say—this sort of popularity will bear a deal of scrutiny.

Toleration of poor work is sometimes due, furthermore, to a desire to keep up numbers; we must retain enough students to pay our bills, and we must not let our "competitors" get ahead of us in size. Either of these motives is unworthy of gentlemen and scholars. To be sure, financial habits of mind may be strong in boards of trustees, but the merest business sense should teach us that the last place to economize is in the quality of our finished product. If we can not save or otherwise secure enough money to make us independent of the tuition fees of those who ought to be dropped, then let us by all means redeem our credit (monetary and moral) by a small increase in the *per capita* charge: a very little arithmetic will prove that a ten per cent. addition to the fee charged each student will enable us to dispense (if need be) with nearly one tenth of the student body, without reduction of income. The "competition" argument is one that it is difficult to discuss politely. Upon what basis, forsooth, are we "competing" in this business of education—upon the number of men that we manage to keep enrolled, or upon the quality of the education acquired by those honestly entitled to attend our courses? Can a self-respecting college aspire to a "success" that is measured by an increase in numbers, which, in its turn, may be due chiefly to a low standard? Is there anything more honorable in educational "competition" than wholesome and courageous pruning?[5]

[5] "Every fall we hear that this college and that has made great gains in numbers. And yet we have no idea whether there have been gains in any vital sense until we know first, what proportion of those admitted are qualified to

None the less discreditable is a sympathy with idle students arising from a similar spirit of idleness in the professor—and yet one is tempted to believe that the real cause of such sympathy is often a kind of unconscious fellow feeling. In few other professions is it easier for the strenuous man to be overworked or for the opposite kind of man to appear to fill his post; so much of the teacher's labor is elusive and impossible to fit into an exact schedule of hours that practically nothing but conscience or ambition can call him to account for loafing, and nothing but his nerves warn him when to rest. Hence arises the fatal risk that—given fallible humanity—this liberty may be abused, and that bridge, golf or literary browsing may take the place of real work; hence, too, the danger that the instructor who is living this delightful life of ease in Zion may not hold before his student the ideal of tireless effort, particularly when he finds that the only sure road to the goal lies through the horrid drudgery of frequent conferences or written papers.

Some of the causes of unwise leniency toward inefficient students which we have been discussing are administrative rather than pedagogical; such are not always conspicuously operative in the creation of "snap" courses. But ignorance of bad conditions—be it perverse or innocent—is harmful in both directions at once; it militates against the toning up of weak courses as well as against honest dealing with obviously worthless students. Take for instance the amiable or uncourageous pedagogue who conducts a "popular" course year after year without making the slightest effort to discover why it is so popular—to determine, that is to say, whether he is exacting a decent amount of collateral work week by week, or whether he is simply delivering an innocuous series of lectures followed by an examination which practically any student can pass after four or five hours over a printed syllabus; and who, if some base traitor hints at inefficiency, is eloquent with denials in regard to conditions which he has never taken the trouble to investigate. And yet it would seem a quite easy matter to discover why our courses appeal to the student body. For instance, we might enquire of graduates (for they are beyond fear or favor)

pursue the courses offered, and, second, whether there has been a corresponding increase in the number and efficiency of the faculty. Of late the only institutions that exhibit much loss in registration are Princeton and Harvard, yet some believe that few institutions have made greater gains in efficiency. This is not a mere coincidence. The dropping of 680 incompetents in six years at Princeton, and the loss of 50 'specials' at Harvard in 1910, has a meaning in progress precisely opposite to the so-called great gains of some colleges. We must rid ourselves of the notion that there is any credit *per se* in enrolment gains. Any college—without exception—can increase its numbers if it is willing to pay the price; just as, on the same terms, jailbirds can be elected to political office in some American cities. Conversely, any college, without exception, can increase its efficiency if it is willing to pay the price, which under present conditions is likely to be a falling off in numbers.'' W. T. Foster, *op. cit.*, 320–321.

whether, in the course which is on our conscience, they ever did any reading before examination time, and how much they found it necessary to do then. Another interesting test[6] would be to compute and compare the average standing of the men who take the different courses year after year, not forgetting to calculate also the average of passes (or perhaps of all the marks) in the various courses. It would not cause great surprise to some observers if such a scrutiny of the facts should indicate that birds of the D feather flock together under those generous trees from which the fruit (the passes, not the intellectual profit) falls with the least coaxing. But it would seem that we are in for a long wait before some administrators and instructors will care to collect facts in regard to scholastic conditions. The snap course goes on, the lazy student stays in college, and the snap professor flourishes like the green bay tree. Evidently this complacent faith of the academic stand-patter in the utter loveliness of the local landscape is a greater breeder of popularity than is the restless spirit of doubt, criticism and reform.

Almost imperceptibly we have been led, in this discussion of academic toleration, from a consideration of its causes to an analysis of its fallacies and its harmful effects. It may have been noticed, also, that, in some important particulars, the influence of the educator who has been characterized herein as a compromiser is in harmony with that of the alumnus or the undergraduate who is altogether hostile to the severely intellectual ideal; for the objection—if any there be—to the comfortable creed of compromise lies not in its toleration of scholarship, but in its friendly feeling for ignorance and sloth, in which gracious capacity it is in complete sympathy with the out-and-out negative. For this reason we may treat these two types together in our further attempt to point out others of their common weaknesses.

In the first place it is quite justifiable to note a little inconsistency. What shall we say of men who despise the intellectual in its practical application to their own college experiences, but who reject with indignation the accusation of laxity in scholastic conditions in the *alma mater?* Is it consistent and honest to boast before strangers of the distinction of scholars whom at home we scorn as students or hamper as administrators? It is said that the late Professor Child, a scholar of whom any university in the world might have been proud, was a butt in the class-room for ill-bred students who took his courses with no desire to learn; it would be interesting to discover whether or not some of these "students" are to-day boasting of the distinction which Professor Child brought to Harvard. And if an officer in a college deliberately takes a stand for a policy of compromise with idle students, what just cause has he to grow angry with critics whose arraignment of

[6] Suggested by President Foster, *op. cit.*, pp. 297–303.

his easy-going methods is simply a bald statement of the truth? Is there no danger that some of our students and faculties may desire to bear the reputation of scholarliness without paying its honest price in hard work or in unpopular justice? One is tempted to point out in this connection the grave injustice that may be done by over-tolerant college authorities to teachers of the strenuous type in their employ. Sometimes it would almost seem to be the explicit belief of these easy-going presidents and heads of departments that the function of the instructor, be he never so promising a scholar or so skilful a teacher, is to spend his time and energies in a vain attempt to cajole illiterate and contemptuous "gentlemen" into the absorption of microscopic doses of learning. To be sure, small wonder should be aroused by the fact that bloodless pedantry and academic priggishness meet with ill success in their contact with lively undergraduates; but, in some institutions, men who are neither prigs nor pedants must either descend to the "popular" level or else court disaster. Some of these mistaken idealists may begin their teaching with a fine ambition to make their courses count, perhaps even with the knowledge that trifling was rampant in their own student days and the determination that it shall not disgrace any of the classes for which they are responsible. And yet their training, their enthusiasm and their ideals are likely to be unappreciated even if they are not positively unpopular; they must either forget these things and drift with the genial majority, or fight a discouraging battle on the side of a minority disliked by colleagues and students. Perhaps it may not often occur to candidates for college positions, nor to heads of departments seeking instructors, to determine whether this lack of harmony exists; but it is quite possible that an honest agreement in regard to the question whether one is expected to teach or to amuse might prevent a certain number of misfits.

Secondly, if the ideal of a college is to be anti-intellectual, or even a policy of compromise, it is only fair that the fact shall be squarely and publicly admitted, so that ambitious parents and conscientious students shall not be deluded. It is merely honest to define our position; if we are conducting a country club with practically optional opportunities for intellectual development, the public should know it. Such institutions should advertise along these lines: "Blank University offers to young men of good disposition four years of pleasant life, combined with social and athletic advantages. Any who are so inclined may attend some of our large assortment of easy and attractive courses; and, if, in addition, they will do a small amount of work, the bachelor's degree will be conferred upon them." With the ideal thus frankly defined, the situation would become clearer, and we could leave institutions of that sort to conclude for themselves whether the social by-products of an unintellectual college life really warrant the four pre-

cious years squandered. If no existing college dares to take quite that stand, then let some benefactor found the University of Dolce Far Niente. Such a venture would not demand much money for libraries and laboratories; and the salary account could be kept very low, since the faculty would not need to be either large or distinguished. A few "interesting" lectures—to keep up the "college degree" illusion and to provide relief from the monotony of serious occupations—would be the only necessary equipment. But this university would be provided with all the attractive decorations of "college life," free from the incubus of work; there would be clubs and "frats," dances and dramatics, beer nights and bonfires—even athletic teams, if the discipline of training and practise could be tolerated. Such an institution would be doubly beneficial; it would provide the ideal place for the idle to prolong their boyhood amid pleasant surroundings, and it would rid educational colleges of material that is now clogging the wheels of progress. Seriously, why not? Why do even the enemies of study prefer universities of distinction to the mere companionship of the club? We may admit that age and tradition often play a large part in this preference, but is it not also true that many idlers find their way into colleges that are by no means old? What then would the University of Dolce Far Niente lack? What but that noble prestige which quickly develops in an atmosphere permeated by the serious ideals of men who, however much they may have delighted in the diversions of the college, have regarded work as its first business? What right, therefore, in such an institution has any man who will not play the game, who will not contribute his share to the maintenance of that tradition, who acts the part of parasite upon the body intellectual?

Life's choices are relative, not absolute; play will be welcomed in the University of Work, and the University of Play will perhaps continue to work between busy days. It is, therefore, largely a question of emphasis, but it is an emphasis which sets off species from species. Hence we can not insist too strongly upon the necessity for frankness in the declaration of our ideal, whatever may be the ultimate merit of the debate over the business of the college. This is vital, for by a confusion of ideals wrong may be done to men of parts eager for an education, but who discover too late that the easy-going institution is not the place to get it. As an illustration of this danger we may quote the remark of a man who was graduated with highest honors from one of the most charming old universities in this country, and who has begun to win more dearly bought success in surgery; his regretful comment upon his college "training" was something like this: "The first thing I had to learn when I got to the medical school was that trifling does not win honors in a serious institution." What that man looked upon as trifling was accepted by his college instructors as honor work; how

much more justifiable are the regret and resentment of the graduate who looks back upon college years that he was allowed utterly and obviously to waste.

In this connection, it may be legitimate at least to raise the question whether a courageous insistence upon real attainment in scholarship would result in the exclusion from college of a substantially larger number of men than the present weaker method does, or whether the result might not be simply to spur to greater effort large groups of gifted fellows who are now floating along the line of least resistance. Would such a policy exclude any men really worth keeping? The belief that college is a place primarily for study implies no contempt for the unscholarly type of man, who is frequently more attractive and occasionally a bit more able (along some lines) than the good student is. But that concession does not alter the obvious fact that only the man who can and will study has any right to be in an educational institution; an ignoramus or an idler is no more in place there than a poet in the supreme court or a college professor in the steel trust.

Finally, this great question of the college ideal is not solely an individual matter; it is altogether pertinent to look at it from the national point of view. So we may solemnly ask the exponent of the country-club ideal whether or not he believes that the American nation should expect her institutions of higher learning to demand hearty devotion to work from absolutely all of those who are preparing for life within their walls and who are supposed to be the material from which her leaders will come in the future. Perhaps we may even go so far as to suggest that a toning up of the intellectual life is one of the great needs of America to-day, and to ask whence this intellectual salvation is to come if not from our centers of education.

It is reasonable to believe that most college teachers do not subscribe to the anti-intellectual creed held by so many parents, alumni and undergraduates; nor do they all, by any means, approve of the policy of compromise of which some of their colleagues are guilty—though it may be that not all of those who believe in the severer standard are sufficiently honest and strong to fight for it. Moreover, it is not unduly optimistic to hold that there has been, speaking broadly, a general toning up of our educational standards in the last ten or twenty years. A great deal of the credit for this improvement may be due to some of our younger and less distinguished institutions, in which a desire for real mental training and for a large acquisition of knowledge is taken for granted, and where creditable intellectual attainments are demanded of every student, either by the spirit of the institution or by the courage of the administration. One can not but wonder whether these modest colleges will not train the Lincolns of the future—in spite of their lack of Oxfordian prestige. But the importance of the non-

intellectual influences that have contributed to the formation of that most attractive and valuable type called the "college-bred man" should never be overlooked even by the most earnest advocate of scholarliness. The traditions of the English university and of more than one fine old college in this country, the atmosphere of ancient culture and public service, the social and even the athletic interests, are of inestimable worth. Hence it is a mistake to maintain that the activities of the man who does not study are always altogether futile. In his favor it is argued—and with great justice—that he may be learning to know life better than he would by close attention to books; and it does not take great faith to believe that some men are actually benefited by an almost wholly unintellectual college life. They play on the field, they manage the team and the fraternity, they sing with the glee club, they write editorials for the daily and stories for the monthly, they sit and chat with their smoking chums, perhaps they even read an occasional book that is not in the curriculum. Still the admission that all is not hopeless does not involve the belief that all is well; the meliorist still stands half way between the pessimist and the optimist. Some incorrigibly cheerful observers who have discovered likable traits in the American undergraduate treat with airy scorn the insinuation that he is unscholarly. This is the attitude of a contemporary magazine writer who, having learned that two mere college presidents (A. Lawrence Lowell and Woodrow Wilson) deplore the low estate of scholarship in our college world, proceeds to show that he knows better. He finds that our undergraduates are enthusiastic (especially in sport), energetic (in non-scholastic activities), honorable, and bent upon reality —ergo everything is lovely. We admit these qualities and rejoice in them; *c'est magnifique*—but it is not the point. Likable qualities doubtless abound in a tribe of American Indians or in a drove of blooded horses; possibly they are more plentiful there than among scholars or artists or successful business men. But it would be as reasonable to pretend that such children of nature could paint a Velázquez or finance a railroad as to imagine that merely likable qualities can take the place of intellectual education. The point is not the charm that groups of clean young men of cultured families are almost bound to possess, but whether these men are developing in college in that domain which is preëminently the business of the college. And this, in spite of all the charming avocations, is primarily intellectual, both by reason of its profession before the world and by its high duty toward these young men; even though it should sacrifice social and athletic activities it must be true to its profession and its calling. But there is no need that it should sacrifice them; it should retain them and vitalize them intellectually. Six hours a day for study and classes is not a schedule likely to lead to nervous dyspepsia; but six hours a day for

six days a week would mean that each lecture and class of a fourteen-hour-per-week schedule would be accompanied by one hour and a half of preparation; college teaching would be paradise if two thirds of that time were regularly given to study by every student. Should we not, then, ponder a little before we glibly sacrifice to "college life" this wonderful, but really easy, opportunity to introduce young men to the world's wisdom, to create a habit of thoughtfulness, and to teach the secret of work? A moment ago we were admitting the possibility of benefit from the better sort of non-intellectual college activities, but the unvarnished truth is that a large proportion of our college shirks do not spend their time in such commendable ways; most of them devote it to aimless idleness and not a few to downright vice. One of the greatest reasons, therefore, why these young fellows should be kept steadily at their studies, regardless of the nature of the knowledge acquired, is that those four precious years between the ages of eighteen and twenty-two are, for many, life's last obvious opportunity to conquer the demon of laziness. And it may be true, too, that a little more study will act as a deterrent to other vices.

The pity of it all is that the delightful accessories should crowd out what was once thought the chief business of educational institutions. But a renaissance of the old belief in the worth of intellectual endeavor and in the power of wisdom seems to be coming; there would appear to be a revival of the antiquated tendency to admire the college administration which declares roundly that the young man who has no taste for knowledge and no desire for intellectual power will not be allowed to waste four years of their time and his—a recrudescence of the old doubt about the wisdom of retaining in college those who will not respond to the demands of a severe intellectual standard, since it is quite uncertain whether such an experience does the trifler a world of good, and altogether likely that his presence does his comrades considerable harm.

At any rate, those who take the honest view of the intellectual life of a college need hardly worry at present about the defense of their position; they need only to proclaim their faith and await results. If they are not rewarded by a distinct increase in the respect felt for them by the community, they may then begin to doubt the wisdom of their choice. Meantime it is important for them to seek to impress more clearly upon their students the value and charm of hard mental labor. Some youngsters may have to take this value on faith for a time; but, even so, we need not wait for these lofty young gentlemen to begin hard work of their own spontaneous choice. Diligence and interest, however, are likely to come hand in hand; where there is a high standard set there is apt to be developed sufficient comprehension of the subject to make it interesting, and interest spurs to effort. After

all, why should there not be a real pleasure, even for a normal American boy, in the growth of the mental powers and in the acquisition of interesting and useful knowledge? Is it preposterous to assume that a healthy-minded undergraduate should be interested in the great thoughts of the ancients and of the moderns, in the mysteries of biology and of physics, in the great creations of art and of literature? If your college student be wholly unresponsive to these stimuli, is it not more or less questionable whether he deserves a place in an educational institution, no matter how delightful he may be as a club mate? To be sure, real attainment of any kind—even in athletics—involves drudgery and discipline; but this condition does not preclude the possibility of a large amount of enthusiasm in the class-room as well as on the field, when once the business of the former shall be taken seriously. And when we remember the microscopic amount of work that now meets requirements in some of our most distinguished colleges, it would not seem to indicate abnormal cruelty on the part of the faculties if they should take a stand for a distinctly more strenuous working day and the benefits to be derived therefrom.

There are, of course, two obvious ways of keeping up our standard —inspiration and compulsion. A few students will respond to the former alone, but for far too many it is—at present, at least—a mere question of "the amount of neglect of his studies permitted an undergraduate without interruption of the privilege of residence." As Dean Fine said to the Princeton alumni a short time ago:

> The typical boy entering a college like Princeton in these days is much more vitally interested in other boys and in sports than in books. To him the lure of college is not in its studies but in its life. By aid of the preceptorial system and other means we are having a good deal of success in transforming these careless young fellows into fair students. But a considerable proportion of them find the undergraduate life and activities so absorbing that in respect to study they will respond to no other impulse than compulsion.[7]

Like the preceptorial inspiration, this compulsion—to be genuinely valuable—should be exerted continuously and not semi-annually. For the ordinary college course no sort of examination has yet been invented which an intelligent crammer can not circumvent by midnight diligence at the end of the term. The reward of this diligence is not always a mere pass; frequently it is an honor mark. Classmates of a brainy Princeton man will recall his "first group" in psychology after a two-hours' session with some printed notes; others will point to the Harvard tutor who secured an idler a B in zoology as a result of five hours' coaching.[8] To be sure, examinations and even the right sort of cram-

[7] "Innumerable devices to coax boys to work have failed in cases where the one thing needful was to convince them, by the evidence of enforced discipline, that they must work or leave college." W. T. Foster, *op. cit.*, 321.

[8] Both of these statements have been verified by the principals. The first is literally true as it stands; the following letter gives the exact details of the

ming may have their uses; but the essential thing is the gradual growth of intellectual power that comes from steady effort distributed over a long period and from frequent discussions with other alert and informed minds. A course which is satisfied by mere attendance through the term is a sorry affair, no matter how much cramming may be needed to pass the examination. Monthly tests go part way towards decency. But ideal conditions are approached only when some test of regular work may be imposed without warning at any moment and when such tests actually do occur frequently.

In addition to preceptorial encouragement and to compulsion born of administrative courage, it would seem altogether wise and possible to spur to greater scholastic activity by the introduction of flexibility into the time factor in education, demanding of those whose work is below par more frequent class meetings or conferences, and consequently lengthening, if need be, their time in residence by a term or two—in other words by establishing a kind of sliding scale in college requirements, adapted to variations in industry and ability.[9] This is a novel idea but a valid one. Any human attainment is the result of intelligence and effort; diminish either and you diminish the result. Unless we are wholly indifferent to the quality of our result, and are content to gradu-

second case:

"The facts of my sin in psychology are these. When I began that course, I was very much bored, . . . and yielded very easily to the temptation of taking things easily in Junior year. As you may remember, the class was very large, so I changed seats with a man who sat in the back of the room, and I used to spend my time in the lecture room reading. I never did a particle of work in the course during term time. As I remember, there were two examinations in the course, one in October and one in February. Someone in [the class of] '94 or '95 had prepared an excellent printed syllabus of the lecture course and the text-book. Having the power of quick memorizing, I worked hard with this syllabus for a few hours before each examination. Not liking the course, I had no desire for any grade, but merely wanted to pass. To my surprise and the demerit of the lecture system, I found that I had secured a first group in both examinations. I really felt more ashamed of this than if I had failed to pass the examinations, for I had learned little about the really fascinating subject, and cared less.

"If ever there is an argument in favor of Wilson's preceptorial system, it is my record in this course.

"You are perfectly welcome to make use of these facts in any way that you wish."

Sometimes it may happen that local patriots will admit the existence of these bad conditions in a remote period in the past, but such a confession would usually be a mere prelude to an airy assertion of absolute virtuousness at present. As a corrective to such optimism it might be well for the complacent to ask themselves whether they ever joined the reformer in his assault upon *contemporary* evils (during their period of power), and whether their inmost soul really loves progress when it involves merciless criticism of the *status quo*.

[9] This proposition is presented in detail by the author in *The Educational Review*, June, 1912.

ate side by side men who are years apart in mental attainment, why do we not endeavor to lessen the gap? Why do we not administer to weaker students smaller and more frequent doses of each subject even though we should thus lengthen their time of residence? If this were done we should have something like a standard, and men would know that they will be kept in the mill until their grist is ground. Then professorial inspiration and compulsion would assume a totally different significance; for, in the last analysis, they would be but spurs. The ultimate cause of prompt success in winning the degree would be the student's own quality.

THE PROTECTION OF DOMESTICATED ANIMALS

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ALTHOUGH we depend to a large degree upon lower animals for food and clothing, the necessity for their protection and the best methods of caring for them do not seem to be fully appreciated. If the Biblical statement concerning the creation is accepted as it is usually interpreted, namely, that man is the foreordained master over dumb creation, our responsibility for its protection is clear. Starting from early time, it is easy to understand that as the human family multiplied it came to require, as it does to-day, a large part of the earth's surface for its activities, thereby exterminating some species of animals and forcing others from a life of natural independence in forest and plain to one dependent upon the action of man. In the evolution of civilization the animals that were needed by the human family were subjected to conditions of life foreign to their original existence and to some extent contrary to their natural instincts. Thus they have been, for no fault of their own, driven from the freedom of the wild to become the property of man, to be bred, to be fed and housed, to be protected or maltreated according to the will of their owners. They are in a certain sense our slaves and must from their very nature continue as such. There is, however, a growing feeling that the hardships which often accompany their servitude should be lessened. There is a demand for their emancipation from the heartless treatment of cruel men. The spirit that is permeating the hearts of people relative to the humane treatment of animals was expressed in the somewhat homely statement of a negro in New Orleans when he first saw an electric car and was told that it came from Boston. "Law me! The Yankee came down and freed the 'niggers' and now he comes down and frees the mules."

An important element that exerts a strong influence toward the better care of dumb creation is a genuine affection which exists on the part of many people for their animals. The devotion of animals to their masters often touches the heart of man and impels him to a humane treatment of his charges. In caring for them it is well to remember that many of the kindest acts from the human standpoint are often out of harmony with the nature of the animals receiving such attention. This frequently results in disease, suffering and death where only health and physical comfort were intended. Many a lad caresses his dog and feeds it the best of his sweets without realizing how much the poor dog longs for a bone.

In pointing out the reasons why domesticated animals should have

better treatment and in considering the means or methods of obtaining for them more complete and efficient protection it is necessary to take into account several somewhat distinct topics, namely:

1. The value of domesticated animals as servants of man and producers of food and clothing for the human family,

2. The sanitary significance of the diseases of animals communicable to man, and

3. The methods best adapted to afford them better conditions of life as determined by the accumulation of knowledge concerning their hygienic and physiological requirements.

If we consider the place animals actually occupy as servants of man and as factors in our economic and living conditions we shall at once recognize the necessity for their proper protection. The dog, ox and horse have served as the great burden bearers in nearly if not all the important industries that have to do with the production and distribution of food. This service will continue to be important. In 1873, when this country was swept with an epizootic among horses, commerce was paralyzed, crops were unharvested, and had this disease been of long duration much human suffering would have prevailed.

The value of animals in the food-producing and other industries can perhaps be best understood from a few statistics concerning the place of animals and animal products in agriculture. The agricultural products of New York state for 1911 were valued at $350,000,000 of which $141,000,000, or nearly two fifths, of the total was of animal origin. More than this, the hay and forage, which constitute one third of the vegetable products of the state, are valuable only because of animals. In Massachusetts, of the annual farm production of $59,000,000, $27,000,000 are credited to animals and dairy products. If we take the United States as a whole, we find that in 1910 the total annual income from agriculture was $8,500,000,000 of which $3,000,000,000, or more than 35 per cent., belongs to the animal kingdom.

It is difficult to appreciate the magnitude of the animal industry of this country. The last census report states that there were in the United States 24,148,580 horses; 61,803,866 cattle, of which 20,625,432 were milch cows; 52,447,861 sheep and lambs; 58,185,676 swine and 292,880,000 fowls. Although these numbers are large, the report shows a decrease since 1900 of 3,485,971 beef cattle, 8,011,326 sheep and 4,682,000 swine. There has been an increase in the number of dairy cows, horses and poultry. The total value of farm animals in 1910 was $5,296,422,000 or about 12 per cent. of the value of all farm property, including land, buildings and equipment ($40,991,000,000).

The report of the chief of the Bureau of Animal Industry shows that the federal meat inspectors in 1911 passed for food 52,776, 855 carcasses of cattle, sheep and swine. In addition to the fresh meat consumed, there were processed under inspection 6,934,233,214 pounds of meat and

meat products. This enormous quantity is only the part that came under federal inspection in 936 establishments located in 255 cities. It is estimated that the packing houses having federal inspection kill only about 60 per cent. of the animals that are used annually for food. Of the remaining 40 per cent. about one half is under municipal or state inspection and the remainder is judged by the butchers only. It is not necessary to go further into figures to emphasize the importance of domesticated animals in the business of the country and their more personal value to us as producers of food and clothing.

In addition to the burden-bearing and the food-producing animals, the pets in dumb creation can not be ignored. The bird, cat and dog have gained a recognized place among the objects of human interest. The breeding of the best species and varieties of these animals has become a large industry. Veterinarians who are specializing in the diseases of pet animals are becoming numerous and many of them have large and well-appointed hospitals.

An investment of such vital importance to mankind as that in domesticated animals should be looked after in a business-like manner. Yet we find in this country that the conditions which tend toward the efficiency and comfort of animals are far from ideal. The necessary precautions by way of food and shelter to safeguard animals against general diseases and to protect them from various forms of infection are not observed by animal owners as fully as would be expected from the present knowledge of those subjects. The losses from disease resulting directly from the lack of such protection are estimated at between three and four hundred millions of dollars annually. Besides this enormous financial waste there is the physical suffering and death of hundreds of thousands of animals. These losses are of more significance than even their totals suggest. The death of a few hens, a hog or a milch cow means but little to the country, as a whole, but to the unfortunate owner it brings not infrequently positive privation. Of productive property there is none more widely distributed among the poor than fowls, swine and milch cows. In thousands of instances these animals constitute the only source of income. When they fall victims of disease, the suffering of their owners for want of food and clothing is often more severe than can be appreciated or understood by those who have not witnessed it. These losses, therefore, in addition to their effect upon the economics of the nation, have a very direct influence upon the physical well-being of thousands of people. The difficulty does not stop here, for the spread of the diseases themselves from animal to man has been the cause of much suffering and many deaths in the human family.

The interrelation of the diseases of man and animals has been the subject of many researches, dissertations, laws and regulations. The Mosaic laws are among the earliest of those for protecting man against infection from animals. In these it is not clear whether or not the

regulations against the use of meat from animals affected with certain diseases were based on the observation that such carcasses were injurious to the consumer or on a religious rite of a somewhat indefinite origin. From the earliest times certain disorders of the human family have been attributed with more or less evidence to infection from animals.

The discoveries of recent years have shown that the specific cause or microorganisms that produce certain transmissible diseases will attack both man and one or more species of lower animals. The most common of these microorganisms are those of glanders, rabies and tuberculosis, although anthrax, cowpox and foot-and-mouth diseases are not infrequently transmitted directly from cattle to man. The studies that have been made concerning the identity of human and animal diseases and the channels through which the infecting microorganisms pass from one species to another have indicated very clearly the limitations of the intercommunicability of disease between man and animals. It has been shown that the channels of infection render it relatively easy for the virus of a few diseases to pass from infected animals to their attendants, but that the reverse is not necessarily true. Thus, there are reported many cases of anthrax, glanders and rabies in man that were caused by direct infection from diseased animals. The cases are very rare where animals have been infected with these diseases from man. This is not because the virus is unable to infect animals, but because from the nature of things the opportunity for it to pass from infected people to animals does not usually exist. There seems to be a popular misunderstanding on this subject. Let me illustrate by rabies. A mad dog may bite several persons, some or all of whom may develop rabies, or hydrophobia, and die. Dogs or other animals are not infected in turn by rabid people. If, however, animals should be properly inoculated with the brain of a person who had died of rabies they would develop the disease and die. The natural method of infection in rabies is through the bite of the infected individual. An instinct of the dog is to bite and when rabid this natural tendency is accentuated, and consequently many dogs, other animals and people may become infected. Biting is not a dominant instinct of man and consequently the rabid person is not liable to bite dogs or other animals. More than this, his environment prevents him from doing so. While the possibility of transmitting the disease exists, experience shows that animals are rarely, if ever, infected with rabies from man. In like manner, anthrax and glanders may be transmitted from animals to their attendants or to those who may examine their dead bodies, but the infected man does not usually come into contact with the animals in such a way that the virus can escape to them. It is natural that man should attend his animals when they are sick, but when he himself is afflicted he does not, as a rule, look after his flocks. In former times there were large numbers of people infected with

anthrax, which they contracted from handling the wool taken from sheep that had died of that disease; likewise many were infected with foot-and-mouth disease which was transmitted to them through the milk of infected cows. There are a few reports that diphtheria has been contracted by the pet cat from the sick child; that birds, especially parrots, have contracted tuberculosis from their attendants; and that poliomyelitis has been transmitted to dogs; but these reports are few in number. There is considerable literature on the transmission of tuberculosis from man to fowls, but the evidence is largely circumstantial. In recent years, large quantities of human tuberculous material have been fed to fowls with negative results. In like manner, the reports of the transmission of tuberculosis from man to cattle are based on circumstantial evidence, and they were made before the knowledge of the varieties of tubercle bacteria had been acquired.

In addition to the infectious diseases, there are a number of parasites which infest people through the medium of pet animals and meat.

The facts seem to be clear that the danger in the inter-communicability of diseases is from animals to man and not from man to animals. This means that in the protection of animals they should be cared for in such a way that their diseases can not pass from one to another, and that those who attend diseased animals should take the necessary precautions to protect themselves. The very definite knowledge of the cause of the communicable diseases makes it possible to minimize the danger to man in caring for infected animals.

To be able to properly care for animals one must understand their physiological requirements. For economic reasons several species of animals have become so numerous and so restricted in their liberties that they must rely entirely upon man to furnish them food and shelter. Presumably they have lost, through continuous living in an artificial environment, much of their original sagacity for self-preservation, and it is not unlikely that they are acquiring a certain amount of adaptation to the new conditions. This intensifies the necessity of inquiring into the best methods to follow in order to give dumb creation the physical protection that rightly belongs to it.

The protection of animals is not different in principle from the protection of man. The problems encountered are similar to those in ascertaining what is best for the physical well-being of the human species. If we could trace the evolution of the present knowledge of hygiene and the physiological requirements of man from his early existence until now, we should find that the influences most effective in bringing about our present conception of living conditions are the results of the study of those physical and biological sciences which combined make up what is known as the medical curriculum. These sciences have interpreted the needs of the body and brought to our assistance the

best we now possess of hygiene and the care of the sick and injured. In like manner the best we know of the nature, care and protection of animals has been derived from the study of the same group of sciences, which are those that make up the veterinary curriculum. We must remember, however, that the care of animals, like that of children, will be guided by the knowledge of those who have them in charge. The task, therefore, is to provide adequate means for ascertaining the nature of the different species and their physiological needs and to have this knowledge made available for and acquired by the owners and caretakers of animals.

The work that is being done in the state experiment stations and agricultural colleges in testing various kinds of forage and food rations is bringing into practical form the results obtained by chemists and physiologists relative to the nutritive needs of different animals. These same institutions are investigating the questions of ventilation, stabling, exercise and other topics pertaining to the best possible care of the healthy animal.

The results of these experiments are published in bulletins for free distribution. Consequently it is possible for all animal owners to profit by the findings.

With animals, as with man, it is the sick and injured that suffer most in the absence of skilled attendants. This fact was observed by Claude Bourgelat who in 1762 established the first veterinary college in the world at Lyons, France. He recognized the need of men trained in the care of injured and diseased horses in the cavalry. He believed that men could be educated in these lines and that a new profession could be developed for the purpose of caring for afflicted animals. A little later there was established a second veterinary school at Alfort with the additional purpose of studying methods to prevent the epizootic diseases that were devastating the animal world. Then other schools arose until a large number of well-equipped veterinary colleges were established in Europe. In this country there are now twenty-one veterinary colleges, of which seven receive state support.

In 1884 the Bureau of Animal Industry was established in the United States Department of Agriculture for researches into the nature of animal diseases. Again, state boards of health and live stock sanitary boards are studying the same subjects. Thus we have in this country institutions to inquire into the nature of the diseases of animals for the purpose of devising methods for preventing them and veterinary colleges to teach men how to treat and to care for the sick and injured. The value of veterinary colleges in this connection is just beginning to be recognized. Until recently little money was available for this purpose and consequently the work was restricted to the teaching of veterinary medicine and surgery in a very narrow sense. Dur-

ing the last few years, however, more funds have been available for this work and much has been done to improve the teaching of veterinary medicine both in treatment and in general hygiene.

As an illustration, perhaps the most important advance in the humane treatment of suffering animals has been in the use of anesthetics. Formerly all operations were performed on animals without the use of any agent to deaden pain. To a considerable degree that practise is continued, but the more progressive surgeons use ether, chloroform, ether cocaine or other general or local anesthetics in painful operations. This is one of the blessings modern surgery has brought to dumb creation. The use of antiseptics in veterinary surgery is saving many animals from the painful and serious consequences of wound infection. The methods of restraining animals for operation are also being improved. Veterinary hospitals are increasing in number and popularity so that animals are receiving more humane treatment when it is necessary for them to come under the surgeon's knife. A like interest is being taken in the advancement of internal medicine. Methods of nursing sick animals that will give to the patient the greatest comfort possible are coming into use. The treatment in veterinary medicine is becoming as rational and as scientific as it is in human medicine. The unwarranted medications for animals that were reported in former times are rapidly disappearing.

With the development of the work in veterinary colleges, all will be done that is possible by way of teaching efficient and humane methods of treatment. However, in the application of modern methods in veterinary medicine there are serious difficulties to be overcome. The veterinarian needs the moral support of the public in applying his art. The condition confronting him is complicated. The afflicted animal is conscious of pain. The operation necessary to restore it to usefulness is severe. The operator equips himself with disinfectants, sterilized instruments and proper dressings. Thus prepared he meets the owner. Shall the animal be restrained in the quickest way possible and operated upon without an anesthetic or shall the comfort of the animal be considered? Here the responsibility of the owner enters, for it is he who orders the work to be done and it is he who bears the expense. The use of anesthetics involves additional cost that some one must pay. It is in this particular that the efforts of the veterinarian to minimize suffering are often checked. What is true of surgery applies to medicine when the proper care calls for additional expense. As the worth of the patient is usually measured in dollars, the amount to be expended for its recovery has its limitations. But a strong effort for humane treatment on the part of practitioners is tending to adjust many of these differences. However, society should take a positive stand on this subject in order to encourage those who are striving for better and more humane methods in treating sick and injured animals. A veterinarian of

my acquaintance recently received, in addition to his fee, a very substantial check from an appreciative client to enable him to use anesthetics on animals whose owners would not pay for it.

This brings us to a very troublesome subject in the protection of animals, namely, the disposition of worn-out horses, homeless cats and dogs and the hopelessly injured. The humane impulse is to destroy them at once. This, so far as we can determine, is the proper course to pursue. It is believed that death is preferable to continued suffering. The question arises, how shall the animal be destroyed? Individuals, and even societies for the prevention of cruelty, frequently impose a method of execution that is not always the easiest for the animals to endure. The insistence upon the use of some anesthetic often imposes upon the animal a more disagreeable death than a well-directed bullet would cause. Yet we often find this and other methods of painless destruction excluded. It would seem that when it is decided that an animal is to be killed the method should be chosen that will give the least suffering.

The slaughter of animals for human food is a disagreeable task, but one that must be performed so long as meat is used. Many investigations have been made to determine the method that will dispatch the animal with the least fright and pain. The conclusion prevails that with cattle at least the most humane method is to stun them before bleeding. This method is observed except in those packing houses where for religious reasons the methods of the ancients are still observed. It is gratifying to note that in one city through the efforts of the humane society and the federal meat inspection, many of the cruelties of the "Kosher" killing have been minimized. In justice to the large packers it should be stated that they welcome any improvement along these lines. If we are consistent in our contention that domesticated animals should be cared for in a humane manner, should not their slaughter, which is for man's benefit, be as easy and painless as it is possible to make it? With the development of new knowledge and better methods many religious rites have been modified. It is hoped that in the near future the Jewish methods of slaughtering animals that have been handed down from early days to the present may in like manner be subjected to certain revisions. As I have already stated, the cruelties of the method have been minimized in one city. Certainly these changes should be made general. Our people can not be too much in earnest relative to the enforcement of methods of slaughter that will protect as far as possible innocent animals from unnecessary pain. This applies not only to the procedures in the larger packing houses, but also to the small butcher and the individual owner who now and then kills animals for food. In the methods of all these there are opportunities for improvement.

In the protection of animals there is need for a more efficient ser-

vice in the eradication of infectious and epizootic diseases. Advancement is being rapidly made, but before the desired results can be attained much additional knowledge must be acquired. Those engaged in this kind of investigation are constantly encountering difficulties by way of limited facilities and funds. The greatest danger, however, that threatens progress in the prevention of disease is the propaganda against vivisection. The time has passed when unnecessary pain is to be tolerated in experimental work. The men and women who are engaged in work requiring the use of animals are sensible of their discomforts. Nevertheless, in the grim warfare against suffering and disease it is often necessary to utilize a few animals for diagnosis. A larger number are required for the preparation of serums and vaccines for therapeutic and immunizing purposes. No one fails to appreciate the importance of minimizing the number of deaths among animals, thereby checking the unnecessary loss from disease. To accomplish this it is sometimes necessary to sacrifice a few individuals in order that epizootics may be checked. In all great crises the lives of a few have been willingly sacrificed in order to save the many. Thus the few animals that were used in the investigation of the nature of Texas fever in cattle and the means by which its virus is transmitted have saved thousands and thousands of cattle from suffering and death from that disease. It is to be hoped that eventually science may give us a substitute for experimental animals. However, the protection against disease that is afforded the flocks and herds of our country warrants the most hearty and loyal support of the principles underlying the present methods of control.

It is impossible in the limits of a single article to discuss adequately all of the essential factors involved in bringing about the desired protection of domesticated animals. Great improvement has been made in the methods usually referred to under the term of the care of animals, such as gentle handling, proper exercise, suitable food and shelter. Betterments along these lines will be made as fast as the acquisition of new knowledge of their physiological requirements permits. Better care of the sick and injured will follow as fast as the owners come to a realization of their obligations to their animals. The suffering and losses from infectious and epizootic diseases will decrease in direct proportion to the application of rational methods for their prevention. The organized efforts to do away with cruelty are more rational and more effective because they are based on scientific principles. The ideal conditions to be attained will come only through the growth of knowledge of the requirements of animals and a deeper consciousness of man's responsibility over dumb creation.

THE FORESTS AND FORESTRY OF GERMANY

By Professor WILLIAM R. LAZENBY
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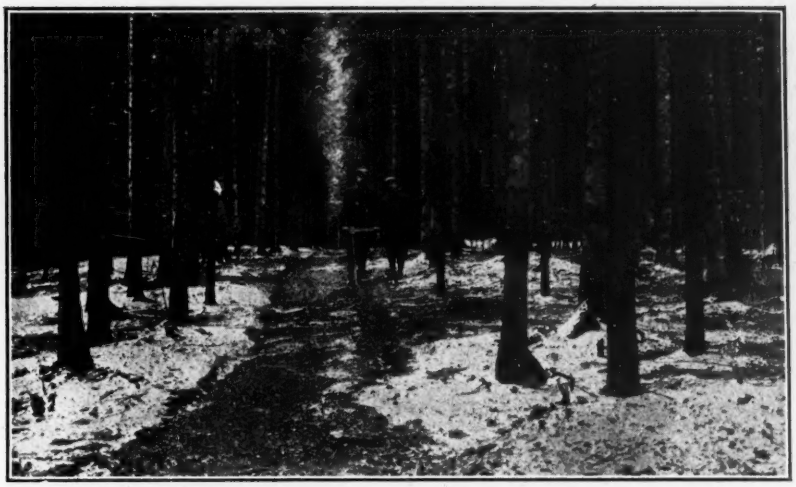
DURING the past year I have had the rare opportunity to observe the forests and to learn something of the general forest policy of various European countries. My interest in this subject prompts me to present a few notes. I am glad to do this because in this country the subject of forestry is now claiming, and is bound to receive, greater attention than has heretofore been given to it.

The increasing scarcity of timber within the first half of the second century of our nation's history, in spite of the variety and richness of its sylva and extent of its primitive woodland, is a condition that calls for earnest consideration and should invoke the interest of every public-spirited citizen. From the standpoint of administration and thorough system the German forest service is not paralleled elsewhere, and its intensive development is nowhere surpassed. Such being the fact, I shall confine myself mainly to what I have seen in Germany.

Why has Germany developed a more systematic, a more advanced forest policy than any other nation? Let us briefly consider. In the first place, it should be clearly understood that the German empire in its federal capacity has nothing whatever to do with its forests. The control of the forests is exclusively in the hands of the various states, which in their confederated form make the nation called Germany. Each state government directs the forest policy of its own state and the national government has never interfered in any way or manner with this procedure.

Speaking of Germany as a whole, the great impetus to a general forestry movement was received about 1750. At that time the population was rapidly increasing and nearly all of the strictly agricultural land had been cleared. Coal had not then been discovered, or was not available for use. There was no fuel, oil or gas, comparatively little peat, and no means of transporting fuel wood from the mountain forests. A succession of winters of unusual severity caused much suffering and the imminence of a general fuel famine stared the people in the face. From this time the art of forestry developed with great rapidity. Everybody was interested because everybody needed fuel. Within a comparatively short time most of the state governments had formulated some forest policy, the principal feature being an effort to secure a continuously sustained yield of fuel wood and timber from all forest lands. One fundamental principle was that no more wood



FINE GROWTH OF SPRUCE NEAR KRONACH, GERMANY. A SLIDING ROAD IN THE FOREST.

should be cut in any one year than was produced the same year. After the coal mines were opened and with the better means of transportation, all fear of a fuel famine passed away, but the practise and conception of conservative, as well as constructive forestry, had taken such a deep hold upon the public mind, that it is small wonder the art has reached a stage of intensive development that no other nation can rival. Through generations of practical tests and experiments, with many failures at first, but with a persistency worthy of the cause and characteristic of the race, German sylviculture has attained a high degree of perfection. Attention is called to a few typical forest areas that were among those visited by the writer.

SPRUCE AND FIR STAND IN A TYPICAL GERMAN FOREST.

The Frankenwald in northern Bavaria is famous for its spruce and fir. The forests of this region are regenerated from self-sown seeds and the system which is carried out with signal regularity is simple to understand and easy to work. It may be said in passing that it produces a marvelously beautiful landscape, one that can not fail to appeal to every lover of nature. The system permits of no clear cutting, so that the harvesting and the growing of trees go hand in hand. Frankenwald is a rugged region, and the hills with their steep acclivities are cut out, or cut over in strips about 300 feet wide. The strips run with the contour, and the logging is started at the top of the hills and thence proceeds downward to the valleys. Thus the second growth is situated above the old growth, and is not further damaged by the continuance of the logging operations. The rotation is 120 years, and at this age the trees average about 15 inches in diameter, and usually cut four logs to the tree. The logs are sent down dirt chutes known as "Lassen." The valleys of the Frankenwald visited are drained by three main creeks, uniting near the old town of Kronach. These creeks are used for transportation, and drives of logs, as well as small rafts, have come down them for hundreds of years. I was fortunate enough to witness the driving and splashing operations, and followed the logs to the mills located along the river.

Another of the large state forests of Bavaria is that of the Spessart Mountains, near Rohrbrun. This is one of the regions where the Bavarian kings and other royal sportsmen are wont to hunt the wild boar. The white oak of this particular forest, which appears to be identical with the English white oak, is justly famous throughout the world. So fine and even is its texture that it yields oak veneer logs of the highest value. Although there is a large amount of this timber, the owner, which in this case is the state of Bavaria, or the whole people, absolutely refuses to sell more than a small annual percentage of the entire stumpage. In this way what appears to be phenomenal prices are secured. For illustration, the price of prime oak logs in the woods, twelve to eighteen miles from a railway, has now reached an average figure of $280 per thousand feet, board measure. Please note that this is the average. The very best logs are selling at $585 per thousand feet board measure. As one who has a hearty love for trees, and one who appreciates the quiet, persistent, marvelous forces of nature set in operation by their growth and development, I felt like taking off my hat when I saw specimens of these oak trees that had individually a cash value in the market of more than a thousand dollars. Under these conditions it is readily understood why the state is eager to reproduce this oak by all means at its command. As 1911 happened to be an unusually good so-called "oak mast year," the writer had the good fortune to see something of the energetic activities of the

WHAT IS CALLED THE 'THOUSAND-YEAR OAK," left as a memorial or curiosity, Spessarto Mts., Bavaria, Germany.

Bavarian foresters in this line of work. Hundreds of acres were thickly planted with white oak acorns, and more hundreds of extra employees were kept busy for six weeks to take full advantage of an infrequent but blessed mast year.

Probably no state has developed a more intensive forestry system, or has done more to place forestry on a sound financial basis than Saxony. This has been due to several causes. Among these may be mentioned, first, the individual work of Heinrich Von Cotta; who is justly regarded as the greatest forester that the world has seen. Second, the forest school at Tharandt, which was founded by Von Cotta in 1811,

and is the first technical forestry school ever established. It has always stood in the front rank of forest schools. Again, the forestry of Saxony is associated with, and has been largely influenced by, Dr. Max Pressler, the father of forest finance and the inventor of many efficient forest implements.

The average rate of revenue from all the state forests of Saxony is close to 2½ per cent. It should not be forgotten that the Saxon forests have gradually risen in value during the past 100 years at an annual rate of 3 per cent.; that is, the total income, counting both cash returns and latent revenue, amounts to 5½ per cent. One of the largest and most progressive lumbermen in the United States has declared he could not see a cash revenue of more than 2 per cent. in forest growth in our country under the most favorable conditions. The lesson from the experience of Germany is that conservative forestry is fairly remunerative at least, when the price of stumpage increases steadily. At present the most all-around valuable timber species in Saxony is the spruce. There is practically an unlimited demand for this wood in the rapidly developing local industries. The spruce is raised in a rotation of 80 years. Clear cutting is practised and the succeeding crops are started by transplanting seedlings from the nurseries. The expense of planting (outplanting) averages about $10 per acre. The Saxon forester, instead of concentrating his logging operations and the subsequent replantings in one place, has a large number of cutting series; that is, he removes a small strip of the oldest trees in each of a large number of places at short intervals of time. Although this increases the cost of logging, the advantages are more than balanced by a lessened loss by windfall in the older stands, and better conditions in way of shade and moisture, decrease of insect injury, etc., for the young plantations. Owing to the short rotation the trees in the Saxon forests are much smaller than are usually seen in Germany. Inasmuch as small timber, saplings and poles, are in great demand, it is found that the smaller sizes are more remunerative investment than the larger trees of a longer rotation.

As an example of a completely rejuvenated forest, the one owned and operated by the city of Heidelberg presents an impressive illustration. A little more than a century ago, this forest, which is on absolute forest or non-agricultural land, was a worthless wilderness. The few straggling trees were decrepit and diseased. The whole forest had been practically ruined, by the combined action of fire, pasturing and reckless cuttings. To-day there are few better or more remunerative forests in Germany. It is an interesting picture, and shows what the art of foresty can accomplish when based on the principles, and operated by the methods, of science. There was one feature of this forest that presented a peculiarly interesting, not to say fascinating, picture

to an American forester. It was some experimental plantations of American trees begun some 30 years ago. In these plantations, as they are seen to-day, are fine stands of Douglas fir, Engleman spruce, Western cedar, hemlock, white pine and many other American species. Careful measurement of the annual growth of these trees have been

A FOREST MACADAM ROAD IN A SAXONY FOREST, showing a fine growth of Spruce on either side near Swartzenberg, Saxony.

taken. The results are equally interesting and instructive. In 1911 the increment per acre, including the branchwood, was, for the Douglas fir, something over two cords, and that of the hemlock was a little more than three cords, while the white pine, which stood the highest on the list, gave a yield of very close to four cords per acre. Whether these

remarkable figures of productiveness will be maintained we can not say. We can say, however, that the German foresters are watching this experiment with lively interest.

No report of German forestry and forests, however brief, could omit to make some mention of the Schwarzwald; one of the most famous forests of southern Germany, commonly known as the "Black Forest." This is a region of enchantment, the recreation ground of Europe, and the delight of all visitors. Here one comes in contact with new economic conditions, new silvicultural types and new ideas in the utilization of forests. While esthetics and sentiment are coming to play an important rôle, the purely commercial aspect of the production of timber is not overlooked. Not many years ago this was the wilderness of Germany. Destructive forestry, not unlike the past, and for the most part even present, American methods of lumbering, was practised in the Black Forest. I visited the holdings of a forest stock company with an historical record covering more than 300 years. In the early days splash dams were made in the rocky, turbulent streams, and the accessible timber was removed and splashed down to the mills located on the river Rhine. The waste was enormous. Since the advent of the railways conditions have changed. The whole forest is a network of excellent macadam and skidding roads. Destructive forestry has given place first to conservative, and then to constructive forestry. The advance of stumpage prices and the introduction of better forestry methods are rewarded by increased revenue. The net income from some of the holdings of this great forest area is better than that of any other forest that I have had the pleasure of visiting. The regeneration is all by natural seeding, and planting is only practised in case of severe windfalls or necessary clear cutting. The two prevalent types of natural reseeding are what are technically called "shelterwood compartment type" and "selection cutting."

In the first type, the regeneration is carried on over large areas, and the standing seeding and shelter trees are removed gradually during a period of from 40 to 50 years. In the "selection cutting type" the regeneration is in patches and the process of seeding is continuous. That type is selected that is best adapted to the prevailing local conditions. The logging operations in some parts of the Black Forest are unique. On the steep slopes the large logs, scaling from 600 to 1,000 board feet, are let down to the roads by means of a long rope one end of which is wound a few times around a near-by standing tree and then fastened to the large end of the log, by a strong ringed spike. The log is started and the rope is drawn around the tree. The man or men who play out the rope hold it loosely or tightly, according to the weight of the log and the steepness of the descent, and the velocity of the log is under perfect control. The logs are guided past the trees and rocks that may be in their way by woodsmen who are both active and expert in this work.

GROUP OF AMERICAN FOREST STUDENTS AND GERMAN OBERFÖRSTERS IN A GERMAN STATE FOREST.

Even in Germany the forester has his troubles. There are still difficulties to overcome, and more or less serious questions to face. I became acquainted with one of the problems of the Saxon state forest. This was near Schwarzenberg, practically in the manufacturing center of Saxony. Here the damage done by the sulphur fumes and other poisonous gases that came from the smokestacks of numerous factories is enormous. No wonder the Oberforster was embarrassed, for the condition of a large area of the forest under his charge was desperate. Trees, dead and dying by the thousands. Fortunately, being of true German pluck and persistency he was not discouraged. He was making some well-directed experiments to determine the species least susceptible to smoke and poisonous fumes. It is now well known that conifers are more affected than broad-leaf species, and that the spruce is the most sensitive of the conifers. This later species is being removed as fast as possible and hardwood species are being substituted. Dr. Wislicenus, of the Saxon forest school at Tharandt, who is a distinguished investigator, has devised a perforated smokestack which he believes will greatly lessen the injury caused by smoke, sulphur fumes and other injurious gases.

Another difficulty of which many foresters bitterly complain is the injury done to seedlings and young trees by deer, rabbits and other forms of wild game. It is true that the revenue from the hunting licenses offset the injury in some degree, yet the absolute loss is often serious and irreparable. All known methods of efficient protection are expensive.

In some states the greatest difficulty of all lies in the exercise of

certain prescriptive rights that are held and exercised by the common people. These rights include the pasturage of domestic animals, the removal of stumps and certain amount of brushwood, the removal of forest litter, etc. These inherited rights are being bought up as rapidly as possible, and the exercise of them is discouraged in every way. In many places where fully exercised anything like modern constructive forestry is impossible.

Still good will sometimes comes from what is generally regarded as evil. In a fine forest near Ysenburg, the ravages of the larva of the June bug made it impossible to plant successfully the seedlings of the pine in the areas to be reforested. It was found that the soil cover of these areas, which had been removed by the inhabitants, and the presence of an unusually large number of hogs, all due to certain prescriptive rights, were the main influences in causing a thoroughly successful natural seed regeneration. Thus was accomplished what had been regarded as impossible.

The financial success of German forestry depends mainly upon two factors. First, good means of transportation, and, second, the owners, whether they be states, cities, royal families, communities, associations or private individuals, only sell annually about the amount of wood that is produced each year. By so doing the market is never overstocked, the demand is always greater than the supply, and the price is kept above the cost of production. The German forest policy aims to reforest all waste or non-agricultural lands, and to gradually increase the forest area under direct state control. It aims to furnish good means of education and training in forestry at the state expense. It is seeking to extend the best possible means of protection, both from animate and inanimate enemies over all forest lands.

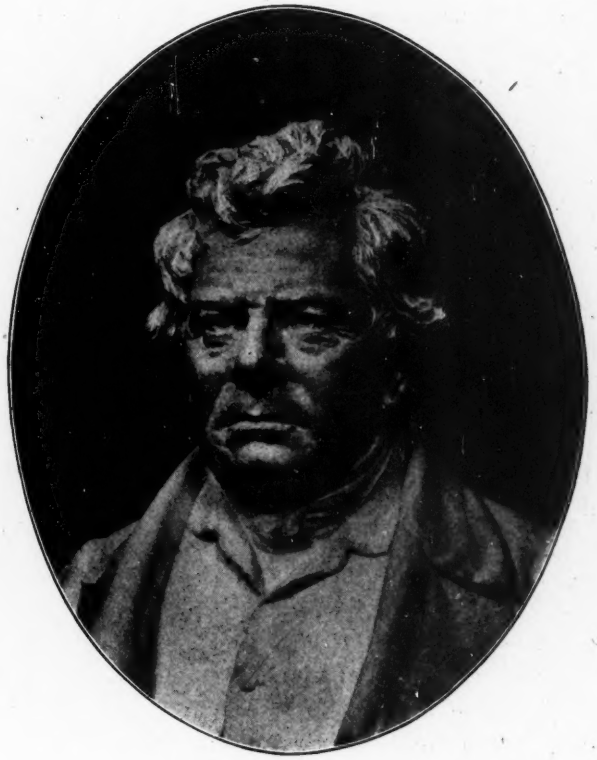
Another feature that we may well imitate is to encourage the largest public use of all forests as a means of health, recreation and enjoyment for all the people. While American forestry should not be content to merely follow European methods and teachings, if we would be really progressive, our leaders must acquaint themselves with the best achievements elsewhere, and up to this time no nation can show such results as Germany.

THE HISTORY OF OHM'S LAW

By Professor JOHN C. SHEDD, Olivet College and MAYO D. HERSHEY, U. S. Bureau of Standards

Introduction

IN the historical development of any branch of science three steps may generally be traced. *First,* there is the growth, frequently in disconnected masses, of a body of data. A few of the more readily grasped



Dr. G. S. Ohm.

facts may find quantitative expression. These formulæ, whether expressed in words or in mathematical terms, prepare the way for the *second* stage, in which investigation is directed toward the discovery of connecting links between otherwise isolated observations. This inductive process of framing and testing hypotheses ends with that comprehensive generalization in concise mathematical form which constitutes a "fundamental" law. The *third* and final stage comprises the deduc-

tive application of the newly discovered law to the prediction of new phenomena. The first stage is generally the longest, the second the most contradictory and difficult, while the third is the most fruitful and may perhaps be regarded as the most interesting.

The branch of electrical science to which Ohm's law belongs is now so well advanced into the third stage, into which it may be regarded as having been ushered by Clerk Maxwell, that it is difficult to look back to stages one or two. Yet eighty-five years ago the theory of electricity was in the first stage, and the years from 1825 to 1860, in some respects, mark the limits of the second. This period includes Ohm's work and that of his immediate successors.

Ohm's work was made possible by the discoveries of Galvani, Volta, Oersted, Ampère, Seebeck and others, whose researches had so broadened the knowledge of phenomena connected with the galvanic circuit as to show the probability of a connecting theory. The formulation of such a connecting theory is the task to which Ohm set himself, approaching the problem from the experimental side. The workers of the early nineteenth century had already in a measure identified and separated the factors at play in the galvanic circuit. Examples of such factors are: the "contact force" at the terminals of the circuit, the "flow of current" along the wire, the "electroscopic force" between any two points of a circuit, the tendency of electricity to escape into the air, and the polarization of the electrodes. There was, however, a lack of definiteness of ideas, as well as of methods of quantitative measurement.

It is no small task to select the necessary from among the incidental factors and to express their relation in concise form. Upon this achievement rests Ohm's chief claim to fame. This is not, however, his only claim to consideration, for besides establishing the law which bears his name, he devised mathematical methods for determining the distribution of electricity in a complex system of conductors, for both steady and variable currents. He did much in clearing up the conception of such terms as electromotive-force, current and resistance. In fact, he did for Volta what Maxwell later did for Faraday. The contributions of Dr. Ohm to the theory of electricity were therefore many sided. They were accomplished because he was a trained mathematician, a skilled experimenter and a keen, logical thinker. A less trained man could not have completed his work; one less honest would have been misled ere the end was reached. Finally, it is interesting to note that recognition of the value of his labors and of the importance of his law came tardily. Like many others, his work was misunderstood and only late in life did appreciation and the ambition of his youth—a university appointment—fall to his lot.

A complete statement of the law discovered by Dr. Ohm involves two independent propositions as follows:

I. $$E/I = R. \qquad (1)$$

In any given circuit, in a steady state, the current I will be directly proportional to the electromotive-force E, and the constant obtained by dividing the latter by the former is termed the resistance of the circuit.

II. $$R = \rho(l/A). \qquad (2)$$

The resistance of a homogeneous conductor of uniform cross-section is inversely proportional to its area of cross-section and directly proportional to its length. The constant ρ entering into the equation is termed the *specific resistance* of the conductor, since it is the value of R when l and A are unity. The first proposition states that whatever else the resistance may depend upon, it does not depend upon the current. The second proposition shows how circuits of an elementary type have their resistance affected by a change of dimensions. It would be wrong to infer that part two gives any information as to the effect of changing the material, or the physical state of the conductor; such considerations form the subject of the modern study of conduction, but the results form no part of Ohm's law.

In text-books of physics part I. is generally quoted as Ohm's law, while part II. is discussed under applications of the law. Whether part II. is to be supposed deducible from part I. or is to be regarded as self-evident is not made clear. Of course neither supposition is correct. Part II. must either be taken as the result of experiment, or be justified by some particular hypothesis as to the nature of the electric current. The student of physics taking up the subject of electro-kinetics after that of electro-statics, might, if left to himself, very naturally expect that resistance would vary inversely as the circumference of the conductor rather than as the cross-section. The true circumstances of current distribution are certainly the last which would occur to the student who, for example, conscientiously followed the suggestions in Watson's "Text-book of Physics," where it is asserted that current flow is a fiction, the only real flow being that of the energized field outside the wire. Whether it is or is not worth while in text-books to exercise more care in the elucidation of Ohm's law, in a historical discussion of the subject ambiguity can only be avoided by a precise statement of both propositions.

In the present discussion let it be remembered that the terms "resistance" and "potential" had not at the time under discussion been applied to electricity. The idea involved in the first term was introduced by Ohm, previous investigators speaking of "conducting power" or "conductivity"; while the term "potential" was brought into the subject later by Green, who borrowed it from Laplace. Ohm does not use it, but speaks of "electroscopic force" and "tension."

Experiments before Ohm.—The list of those who may properly be associated with the historical development of Ohm's law is a long one. Even when one omits those who studied the applicability of the law to

electrolytes and gases, and confines it to those who contributed to the subject by the study of solids only, it includes the names of Cavendish 1750–1837, Priestley 1733–1804, Children 1777–1852, W. S. Harris 1792–1867, Davy 1778–1829, Barlow 1776–1862, J. Cumming 1777–1861, A. Becquerel 1788–1878, Ohm 1789–1854, G. Fechner 1801–1887, Pouillet 1790–1868, Lenz 1804–1865, S. H. Christie 1784–1865, Ritchie 1814–1895, C. M. Despretz 1792–1863, Kirchhoff 1824–1887, J. M. Gangain 1810–1878, Weber 1804–1891, Maxwell 1831–1878, A. Schuster 1851– and G. Chrystal 1851–.

The first person on record to investigate the relation between electromotive-force, current and resistance, afterwards formulated as part I. of Ohm's law, was *Henry Cavendish,* of England. His work was done prior to 1775, but remained totally unknown to the world until the publication of the Cavendish Researches by Maxwell, in 1879. Besides certain experiments on the relative conductivity of the human body, of iron and copper wire, and of various liquids, he made four series of experiments to determine "what power of the velocity the resistance is proportional to." In these experiments he employed a collection of wide and narrow glass tubes filled with a salt solution. As a source of current he used the discharge from a Leyden jar. The experiment consisted in adjusting the length of the column of liquid in the tube under test until it permitted the passage of a discharge of the same strength as that through a second tube selected as a standard. Under these conditions the resistances of the two tubes were regarded as equal. His method of determining equality of discharge was to place his own body in circuit with the condenser and test-tube, and then to judge by the sensation experienced. This is perhaps the only case on record where the human body has been used as a quantitative instrument in electrical measurements.

As a result of these experiments Cavendish concluded that the "resistance," in his sense of the word, varied as the 1.08, 1.03, 0.976 and 1.00 power of the "velocity" in the respective experiments. Maxwell tells us that by "velocity" Cavendish meant current and by "resistance" the total force opposing the current. This would make the Cavendish resistance equal to the total fall of potential around the circuit and is equivalent to saying that the resistance, in the modern sense of the word, is independent of the current. In his fourth experiment, which was the one most carefully performed, the result is in exact accordance with the modern view, and considering the crudity of his method all four results may be said to check within a reasonable margin of error. The work of Cavendish was on this basis regarded by Maxwell as an experimental proof of Ohm's law, and it was in this light that he left the matter in editing the Cavendish papers. No one since then seems to have done anything further than quote Maxwell.

Nevertheless, a closer examination indicates that Maxwell's state-

ment that Cavendish's fourth experiment "is the first experimental proof of what is now known as Ohm's law," must be taken with some reservation. The conclusion one reaches is that Cavendish tacitly assumes part II. of the law. It is true that in 1775, two years after the above experiments, he states the law for the combination of resistances in parallel and in series though he does not state how he arrived at it, nor does he give any experimental data in proof of his statement. It can therefore hardly be regarded as part of his experimental proof of Ohm's law. With respect to the effect of cross-section on resistance Cavendish's only recorded experiment consists of a comparison of the shock received through nine small tubes with that received through one large tube of equivalent section and the same length. The fact that the two shocks were equal does not settle the relation between resistance and cross-section except for the case of round conductors. Ohm expanded the work to include sections of other shape. It would seem to be clear that Cavendish can not be credited with the establishment of both parts of the law, and strictly speaking it is an error to speak of him as the "discoverer" of Ohm's law. The most significant obstacle in the way of his doing this was, no doubt, the fact that no such thing as a steady current had as yet been discovered.

Subsequent to these, as yet unknown, experiments of Cavendish, but before the discovery of steady currents, work on the conductivity of different metal wires was undertaken by Van Marum, Priestley, Children and Harris. Using as they did the static discharge as a source of current, their work shows no advance over that of Cavendish either in results or in method. *Peter Barlow,* of England, was perhaps the first to attempt to use a steady current in the study of resistance. He did this by placing successive wires between the terminals of the same voltaic pile, determining the current strength from the tangent of the angle of deflection of the needle of a "multiplier" (galvanometer). The conclusion that he reached was that the resistance of a conductor is directly proportional to the *square-root* of the length and inversely proportional to the cross-section. In looking over the data of these experiments one finds discrepancies of 6° to 7° between the observed and calculated deflections based on Ohm's law. This makes it possible to estimate the resistance of the pile, which ought to have been, but was not, included in considering the resistance of the circuit. Such an examination of the data leads to the conclusion that Barlow's failure to reach correct results was due to this neglect of the resistance of his source of current. Had he included this he might have anticipated Ohm, at least to the extent that Cavendish did.

Cumming used the thermoelectric instead of the voltaic pile as a source of current, otherwise his experiments parallel Barlow's, including the same mistakes and reaching the same erroneous conclusions.

Davy: We now come to the first experimenter using steady currents

whose results accord with those of Ohm. Sir Humphry Davy about 1820 used a voltaic pile and a divided circuit, one branch of which contained apparatus for the decomposition of water and the other the wire under test.

Fig. 1 shows the disposition of the apparatus.

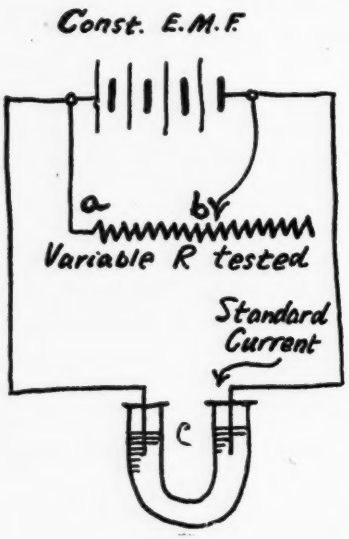


FIG. 1

The experiment consisted in adjusting the length of the wire *a–b* until its shunting effect was such as to make the potential difference across the water-cell just sufficient to cause electrolysis to begin. He found that wires having the same ratio of length to cross-section had the same resistance. This fact, while in accordance with Ohm's law, is a necessary but not a sufficient condition for its establishment. It is, in fact, the same result that Cavendish had reached forty years before.

Becquerel: Antoine Cesar Becquerel, the first of an illustrious line of French physicists, was the discoverer of part II. of Ohm's law. As his rival, Ohm must certainly have been incited by him to greater efforts in his own study of conduction, and in his earliest published papers Dr. Ohm accords to the work of Becquerel both recognition and criticism. Becquerel, like all of the predecessors of Ohm, overlooked the significance of the internal resistance of the source of current, but like Davy his use of a null method eliminated the necessity of taking it into account.

In his experiment Becquerel wound two wires simultaneously on to the frame of a "multiplier" (galvanometer). The terminals of the two coils thus formed being brought out separately could be connected so as either to increase or to oppose each other's effect. In the latter case what is known as a differential galvanometer is formed, the first one on record. Becquerel connected the coils differentially and in parallel. In order now that the coils shall exactly balance each other it is necessary not only that the number of turns of wire be the same on the two coils, but also that their resistance be the same. Since, however, the wires were of different diameter this could only be accomplished by increasing the length, outside of the instrument, of the coil of lower resistance. From one set of experiments Becquerel found, as had Davy before him, that all wires having the same ratio of length to cross-section had the same resistance. But to this experiment he added another showing that the conducting power varied inversely as the length of the conductor. The

combination of these two results led for the first time without ambiguity to the conclusion that the conducting power varies directly as the sectional area and inversely as the length of the conductor, thus constituting a complete statement of part II. of Ohm's law. Becquerel also determined by direct experiment that the total current is the same in every part of a series circuit. This fact, so familiar to-day as to seem all but self-evident, was an important one, for without it Ohm's law would be meaningless.

Ohm's Experimental Investigations.—George Simon Ohm was born in Erlangen, Germany, on March 16, 1789. After attending the university of his native town he taught in Gottstadt, Neufchatel and Hamburg. In 1818 he became the teacher of mathematics and physics at the gymnasium at Cologne, where he remained for nine years. He was a superior instructor and looked forward with the ambition of securing a university appointment. Then, as now, the best, if not the only, path to preferment lay along the line of scientific research and discovery. To this endeavor Ohm brought three prime qualifications. His father, who was a lock-smith, had trained him as a lad in the use of tools; from his university he gained excellent training in mathematics; in himself he possessed a firm determination to do his best and a strong ambition to succeed. With scant leisure, few books and only the apparatus he himself devised and for the most part built, he had need of patience and perseverance. Difficult as was his progress, he was able in 1825 to publish three papers dealing with the galvanic circuit.

I. The first of these, entitled "Vorläufige Anzeige des Gesetzes, nach welchem Metalle die Contact-Elektricität leiten," occupies eight pages of *Schweigger's Journal für Chemie und Physik,* and describes experiments on the "loss of force" (*i. e.,* loss of potential) due to increasing the length of the wire in a simple circuit. In modern language it is the study of the effect on the terminal potential difference of varying the external resistance of the circuit. The results of these experiments were expressed by Ohm by the following empirical formula,

$$V = m \cdot \log\,(l + x/a). \qquad (3)$$

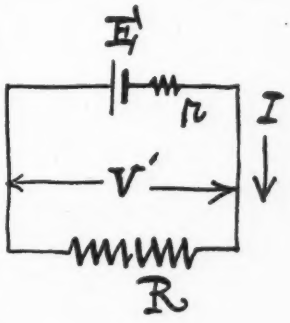


FIG. 2

In this equation V is the loss of terminal potential difference, due to the insertion of an external resistance of length x, a is a constant depending on the length of the connecting wires, and m a coefficient depending (supposedly) upon the electromotive-force of the circuit, the cross-section of the wire and the constant a. The scheme of the experiment is shown in Fig. 2.

In the light of Ohm's later work it is easy to see that this formula is absurd, a conclusion indeed soon reached by Ohm himself. It however marks one of the steps in the discovery of the law, and an examination of the experimental data shows that it represented these data very closely. Ohm was not however to be long misguided by an equation which could be easily checked by increasing the range of the experiment. He saw that, no matter how precise equation (3) might prove as an approximate formula, it could hardly represent a law of nature. He therefore prepared to test an external resistance fifteen hundred feet long. .He does not seem to have published the result of this experiment, but he must have seen his mistake, for he promises to develop a new and correct equation. This he did a year later.

II. Two more papers were published by Ohm in the year 1825, as follows: "Über Leitungs-fähigkeit der Metalle für Elektricität," containing a preliminary announcement of his studies on the relative conductivities of different metals. The results were published the following year and are considered under paper IV.

III. "Ueber Electricitätsleiter." This was a discussion of the discrepancy between the results of Barlow and Becquèrel, together with the acknowledgment of the inaccuracy of his own formula for the "loss of force" and an intimation of his intention to revise the formula. This closes the work for the year 1825. During these experiments he used for the source of current a Cu-Zn cell and measured the potential difference by means of a Coulomb torsion balance. The progress of the work is marked by a clearing of the way, by a grasp of the problem and a development of method rather than by positive achievement.

IV. Two papers appeared during the year 1826: the first of these was by far the most important and was a long one of twenty-nine pages, entitled "Bestimmung des Gesetzes, nach welchem Metalle die Contact-Electricität leiten, nebst einem Entwurfe zu einer Theorie des Voltaischen Apparates und des Schweigger'schen Multiplicators." While not so well known as his book on the mathematical theory of the circuit, published a year later, it is in reality his most important work and contains the following results.

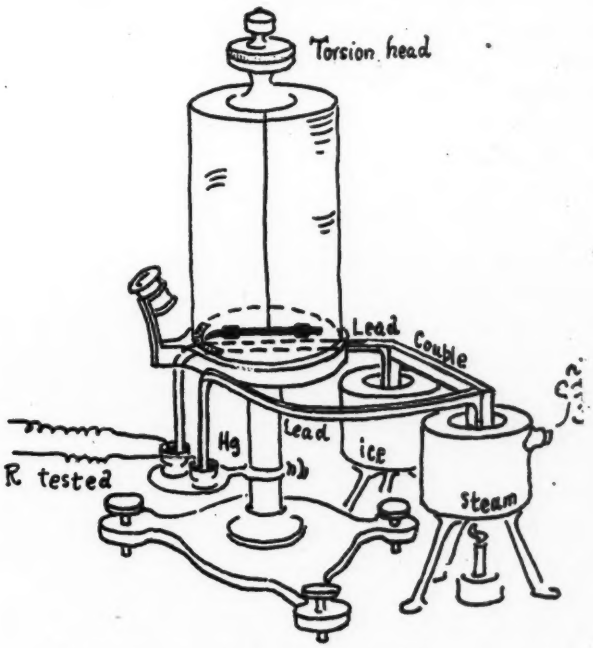
1. The data on relative conductivities promised in paper II. Ohm measured the relative conductivities of copper, gold, silver, zinc, brass, iron, platinum, tin and lead. Without going into the details of these experiments it is important to note that Ohm had gained a thorough appreciation of the significance of the specific conductivity of a conductor.

2. Experiments showing that the resistance of two conductors is the same when they have the same ratio of length to cross-section. Ohm's first experiments on cross-section proved the proposition which had already been proven by Davy and Becquerel, namely, that the resistance

depends upon the ratio of length to cross-section. The second experiments comprised the comparison of the currents flowing through two conductors of equal length and equal cross-section, one of which was of circular and the other of very flat section. The result showed that with the same electromotive-force the currents were also the same, thus proving the current to be uniformly distributed throughout the section. His third series of experiments gave a verification of the laws of parallel resistances. These results constitute a full experimental proof of part II. of Ohm's law, which, in its entirety, had not been given up to this time.

3. Experiments showing the relation between the magnetic effect of the current, the electromotive-force of the cell, and the length of wire in the circuit. This is the relation which we have denominated part I. of Ohm's law. He first presented it in the rather unfamiliar form of the following equation.

$$X = a/(b + x), \tag{4}$$



Ohm's Torsion Balance and Thermocouple

FIG. 3

where X is the magnetic effect of the current, a and b are constants depending respectively upon the electromotive-force and the internal resistance of the source of current; x is the length of wire constituting the external resistance under test. In modern language equation (4) may be written,

$$I = E/(r + R). \qquad (5)$$

The experiments by which these results were established constitute the most important of Ohm's work and they well repay careful study. After some preliminary experimentation his apparatus was reduced to the following essential parts: a Cu-Bi thermo-couple for generating a steady current and a specially constructed magnetic torsion balance for measuring the current strength. The apparatus and scheme of connections is shown in Fig. 3.

During the earlier part of his experimental work one thermo-juncture was surrounded by a steam-jacket and the other by an ice-jacket; during the latter part of the work the hot juncture was left at room temperature. The procedure for the experiment was as follows: The steam and ice jackets were first brought to their respective temperatures, the length of the test wire was then adjusted to the required length and lastly the torsion head turned until the magnetic needle was brought back to its zero position. The reading of the torsion head was then recorded and the experiment repeated with a new length of wire.

With the completion of these experiments Dr. Ohm had established both parts of his law, and may be said to have solved the problem to which he had set himself. As in the case of Sir Isaac Newton and the law of gravity, Ohm now found himself in the possession of a key to many doors closed to previous workers, and he proceeded at once to use it, as is shown by his theoretical paper of 1826 and his book of 1827.

V. This paper was published in the Poggendorf Annalen, is ten pages long and is entitled "Versuch einen Theorie der durch galvanische Kräfte hervorgebrachten elektroskopischen Erscheinungen." It is a purely theoretical paper and foreshadows the book which he wrote the following year. In this paper Ohm enunciates his complete law, contrary to the widely accepted statement that the law was first given in the book of 1827 (*e. g.,* Reed and Guthe, "College Physics," 1911). It also contained the correct formula based on this law, for the change of terminal potential difference due to a change in the external resistance. Finally the application of the law to many practical problems is discussed.

VI. The year 1827 furnishes the final paper of the series upon the galvanic circuit, followed by the appearance of the book elaborating the newly discovered relations. This paper appeared in *Schweigger's Journal* and was entitled "Einige elektrische Versuche." It is a paper of eight pages and contains the results of two experimental investigations confirmatory of the work of the previous year, as follows: (1) A verification of the conclusion as to the uniformity of the distribution of current over the cross-section of the conductor; (2) a verification of the formulæ for the combination of resistances in parallel. This may be

said to close Ohm's experimental work in so far as it relates to the establishment of the law under discussion.

Ohm's Theoretical Work.—Turning to the mathematical interpretation which Dr. Ohm gave to the mass of experimental material already considered, we will first examine the paper of 1826 cited above under V. At the beginning of this paper is found the following expression of Ohm's law:

$$X = k \cdot w \cdot a / l, \tag{6}$$

where X is the current strength, k the specific conductivity of the wire, w the cross-section, a the electromotive-force of the source of current and l the length of the conductor. A second equation brings out for the first time the conception of "reduced length" or resistance. This equation is

$$X = a / L, \tag{7}$$

where L is the length of a hypothetical wire of unit conductivity and unit cross-section and takes the place of the terms $k \cdot w / l$ in equation (6). Equations (6) and (7) constitute Ohm's formal expression of the law.

In 1827 Dr. Ohm secured leave of absence from the gymnasium in Cologne, and proceeded to Berlin for the purpose of bringing out a book which should contain the theoretical conclusions which he had elaborated from his experiments. This book is entitled "Die Galvanische Kette, mathematisch bearbeitet," "The Mathematical Theory of the Galvanic Circuit." This book is the best known of his works. It contains a comprehensive theory of galvanic electricity, deduced from simple hypotheses and developed mathematically so as to cover a multitude of practical cases. The book may be divided into two parts, of which the first contains an introductory statement of principles on which the theory is based, together with applications to simple problems. Part two involves the use of differential equations and constitutes a more general development of the theory. The absence of a table of contents would seem to indicate haste in getting the book issued. An examination of the text gives the following partial outline of its contents:

Part One: 1. Discussion of the three fundamental hypotheses lying at the basis of his general theory and dealing with (*a*) the distribution of electricity in any element of a body; (*b*) mode of dispersion of electricity into the atmosphere; (*c*) law accounting for the generation of contact electricity. Of these three only the first is directly concerned with Ohm's law. Of it he says: "I have started from the supposition that the communication of electricity from one particle takes place directly to the one next to it. The magnitude of the transition between two adjacent particles under otherwise exactly similar circumstances, I have assumed as being proportional to the difference of potential between them."

In this passage it will be seen that Ohm proposed to follow, in the consideration of the flow of electricity, the lines laid down by Fourier

and Laplace for the flow of heat. In fact Ohm does this throughout his book, and in a passage, unfortunately omitted by the English translator, he explains the analogy and acknowledges his debt.

2. After discussing the three principles Ohm applies them to a simple circuit of uniform section and material, in order to obtain a graphical representation of the potential gradient (*Gefalle*) and its discontinuities.

3. Applications to linear circuits of different material and varying section, with a generalization of the graphical method.

4. Equation for determining the potential at any point, consisting of an algebraic interpretation of the foregoing graphical method.

5. Relation of current strength to the potential gradient. This is Ohm's law expressed in terms of current, electromotive-force and "reduced length" or resistance. It is this statement of the law which is frequently, though wrongly, taken as the earliest expression of the law.

6. Applications of the conceptions of *potential gradient* and *reduced length* to special cases.

7. The effect upon the current strength of varying the resistance.

8. Properties of thermo-electric and hydro-electric circuits.

9. The effect upon the electromotive-force and resistance of the number of elements of a battery.

10. Adjustment of the resistance for the best action of a galvanoscope.

11. Divided circuits.

12. The decomposing power of an electric current.

The second part of the book is mathematical in character and need not be outlined here.

Discussion and Summary.—We are now in a position to summarize Dr. Ohm's work in the establishment of the laws of conduction, and to place his experimental work of 1825–26 in proper perspective with respect to his theoretical work of 1827. In doing this it will be necessary *first* to trace the development of ideas in Ohm's mind, and *second* to see how the scientific public received the same knowledge.

In tracing this development in the case of Ohm one must infer that the order of appearance of his various published papers marks the stages of growth of his own knowledge. Following this suggestion we find, *first,* that Dr. Ohm published in 1825 an incorrect empirical formula based upon inadequate experimental data. This paper would seem to show signs of undue haste caused perhaps by a fear that some other worker, Becquerel for example, might anticipate him. If this premature publication can not be placed to his credit his prompt acknowledgment of the error must be. *Second,* after further experimentation he announced the true law in 1826, in somewhat different form from that in which it is familiar to modern students. In the *third* place, he framed certain hypotheses from which the law could be deduced. This he does in his book of 1827. In doing this and in elaborating the law and in extending it to a large number of practical cases, Ohm leaves the reader to infer that he starts from the hypotheses and not from

experiment. This is a serious mistake on the part of Ohm and it is hard to see just why he did himself this injustice. He may have assumed that the scientific public was familiar with all of his printed papers—an unsafe assumption at any time—and that direct reference to them was unnecessary. Ohm's book was only made possible by his experimental work and everything of value in it is the direct outcome of the laboratory, yet in the book Ohm writes as if the results reached were deductive and based on the three hypotheses cited above. In this Ohm laid the ground for the misunderstanding of his work by his contemporaries, who did not realize that its basis was experimental and therefore subject only to experimental proof or disproof.

Perhaps Ohm thought that the rather meager foundation of experimental data would be regarded as inadequate for the superstructure, or it may be that he really felt that the experiments had led him to the knowledge of the fundamental causes of the phenomena of conduction, and that his theory was more secure by being logically developed from these supposed fundamental truths. In either event he retarded rather than helped his cause. A third reason that might be assigned would be his desire, supposing him to have it, to be regarded as a *deductive* rather than as an *inductive* philosopher. He had, of course, imbibed some of the modern view of the importance of experimentation, else he would not have experimented, but he very likely still retained a good deal of the old Greek notion that by a process of pure reasoning one may reach new truth. In this case experimentation is not so much a source of new knowledge as a new form of thought stimulation. From such a viewpoint the experiments of Ohm had indeed served their purpose so soon as they were completed and he was quite right in ignoring them. Such a view of Ohm's position is strengthened by the fact that he seems to have taken no pains to remove the impression, universal in his day and which persists somewhat even to the present, that his laws were based on theory only and had no experimental origin or support.

So far then as Ohm is concerned we must conclude that however much he may have valued his experimental work for himself, he was well content that the public should consider his laws as being of theoretic and not of experimental origin.

The view which the scientific public early reached as to the value of Ohm's work is well expressed in the following paragraph taken from Cajori's "History of Physics" (pp. 230–1):

> The following year Ohm published a book entitled "Die Galvanische Kette, mathematisch bearbeitet." It contained a theoretic deduction of Ohm's law, and became far more widely known than his article of 1826, giving his experimental deduction. In fact, his experimental paper was so little known that the impression long prevailed and still exists that he based his law on theory and never established it empirically. This misapprehension accounts, perhaps, for the

unfavorable reception of Ohm's conclusions. Professor H. W. Dove, of Berlin, says that, "in the Berlin *Jahrbucher für wissenschaftliche Kritik*, Ohm's theory was named a web of naked fancies, which could never find the semblance of support from even the most superficial observation of facts." "He who looks at the world," proceeds the writer, "with the eye of reverence must turn aside from this book as the result of an incurable delusion, whose sole effect is to detract from the dignity of nature."

In seeking to explain how this extraordinary opinion came to be held the following facts will be of aid:

1. The paper containing Ohm's principal experimental results was published in a German scientific periodical and has never been translated, whereas his theoretical deductions, published in German the very next year, have since gone through two English and one French edition. The theoretical results were therefore far more widely diffused than were the experimental. Indeed it would be easy for a reader of both publications to confuse the priority of two so nearly simultaneous documents.

2. It was only by virtue of the recognition, tardily but distinctly rendered, on the part of Fechner in Germany, Lenz in Russia, Wheatstone and others in England, that Ohm came out of obscurity. Until this was the case and recognition was given by men of recognized standing, there was little reason why any more attention should be given Dr. Ohm and his meager set of experiments than to a number of equally reliable and equally little-known workers, whose results disagreed with his.

3. To whatever extent the English translation may be supposed to have supplied information as to the degree of interdependence of theory and experiment matters could not have been helped by an inexcusable error of translation of a sentence, the German of which is as follows: "Die Grosse des Überganges zwischen zwei zunachst beisamen elementen habe ich unter übrigens gleichen umständen dem Unterschiede der in beiden Elementem befindlichen elektrischen Kräfte proportional gesetzt." This sentence occurs near the beginning of the book and immediately after an intimation that his hypothesis depends in part on experiment, and a wrong rendering must have conveyed a false impression of the real character of the experiments, and therefore of their value. The rendition of this important sentence is: "The magnitude of the transition between two adjacent particles under otherwise exactly similar circumstances, I have assumed as being proportional to the difference of their temperatures."[1] How the word "temperature" came to be rendered for "elektrischen Kräfte" is difficult to see, and it can not be called an improvement on the original.

4. In his paper of 1826 Ohm did not very fully set forth part II.

[1] A correct translation is given on a former page.

of his law, the following being his expression: "Cylindrische Leiter von einerlei Art und verschiedenen Durchmesser haben denselben Leitungswerth, wenn sich ihre Langen wie ihre querschitte verhalten," which may be rendered: "Conductors of the same material have the same resistance if they all have the same ratio of length to cross-section." Now while this condensed statement is equivalent to the more elaborate statement contained in the book of 1827, this fact might easily be overlooked by a casual reader. It is also to be remembered that in the earlier stages of the discussion of Ohm's law part I. received general acceptance, while part II. was by no means universally agreed upon.

5. Lastly the fact that he wrote his book from a theoretical and not an experimental point of view invited the judgment passed upon it that his conclusions were "a web of naked fancies" without "the semblance of support from even the most superficial observation of facts."

From a modern point of view it may well be questioned whether the two propositions constituting Ohm's law could ever have been arrived at by any other than an experimental route. Weight is given to this conclusion by the following: (1) Our present knowledge of certain deviations from Ohm's law are accounted for only by the present corpuscular theory of electricity. Now Ohm, so far as he developed his ideas theoretically, did so on the basis of heat flow and the theory of heat was not corpuscular. While such ideas may not be opposed to the corpuscular conception, we can not expect an inadequate conception at the basis of a theory to lead, by a process of deduction, to correct predictions. The same partial conception may, however, prove of great value in an inductive process which is checked at every step by experiment. (2) In the formulation of a theory so essentially simple as is Ohm's law, one must look for a background of clear ideas, and we can admit of but one source of data for this purpose—namely, experiment. The absence of clear ideas of such terms as *current flow, resistance* and *electromotive-force,* at the time of, and their presence after Ohm's work is direct evidence of an experimental source of information. Thus the mathematical theory of electrostatics was based on Coulomb's law experimentally established, and a similar experimental basis was necessary for Ohm's law.

The discussion of the origin of Ohm's law may then be summarized as follows: Dr. Ohm carried along his experimental or inductive work simultaneously with the theoretical or deductive work; first the one then the other was to the front, until finally in 1826 he was able, from his experimental data, to announce the true law. In 1827 he ill-advisedly advanced his hypotheses as the origin of his theory without making it sufficiently clear that they were based on experiment. As an example of deductive reasoning the law means little, while as an exam-

ple of inductive reasoning the law marks an important stage in the progress of science, and in its simple, generalized form is found to be identical with our present wider knowledge, so long as we avoid such phenomena as the skin effect, the Hall effect and conduction through gases.

Ohm's law thus experimentally discovered has stood the most exacting tests that modern methods have made possible. It has served as a firm basis for the progress of electrical science and marks the transition from the somewhat haphazard disconnected researches of those who preceded, to the well-directed, consistently developed labors of those who followed him. In a less degree and in a more limited field Ohm did for a branch of electrical science what at an earlier date Newton did for the great field of mechanics.

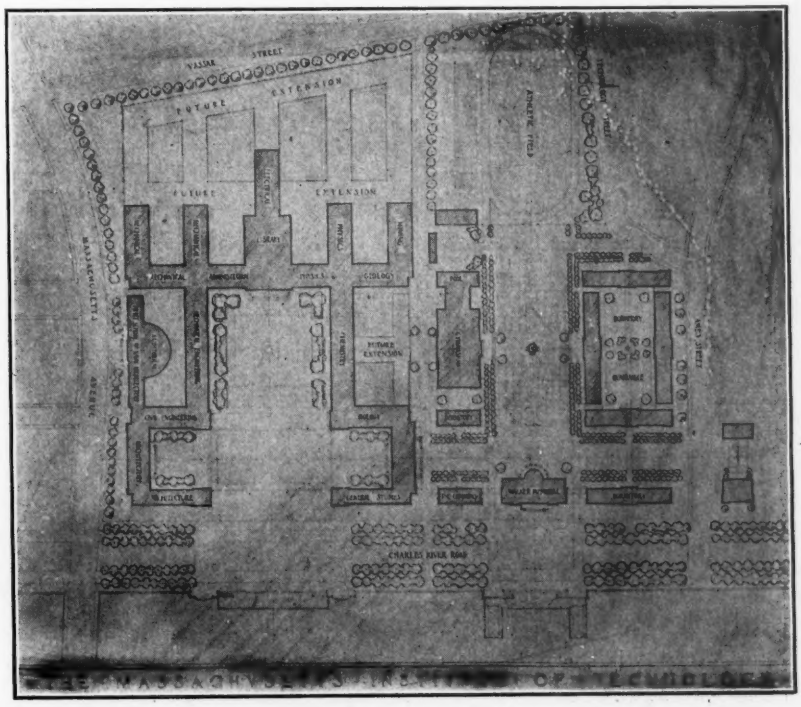
THE PROGRESS OF SCIENCE

THE NEW BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

WORK has begun on the new buildings for the Massachusetts Institute of Technology, and it is expected that they will be occupied two years hence. It will be remembered that after long discussion it was decided that a new site for the institute was required, and after the accession of Dr. Richard C. Maclaurin to the presidency and a gift of $500,000 from Mr. Coleman du Pont, land was purchased in Cambridge fronting the Charles River basin. An anonymous gift of $2,500,000, followed by another gift of $500,000 and an equal sum subscribed by the alumni, has enabled the institute to proceed with the construction. Six months ago, Mr. William W. Bosworth, of New York, a graduate of the institute of the class of '89, was selected as architect, and with the advice of the officers of the school of architecture of the institute and of the professors in the different departments, designs have been drawn up. The ground plan here reproduced shows the extensive scale of the plans, and some indication of the architectural treatment is given in the sketches.

The educational portion is a connected group of buildings of white Indiana limestone, three and four stories in height, clustered about the library, as the central feature. The great dome looks down on the court from a height of nearly two hundred feet. The central court, open to the river front, expands into two large, though minor courts, when near the esplanade. These openings, with the other courts interior to the buildings, ensure the necessary lighting of the rooms.

The pilaster treatment, so effectively



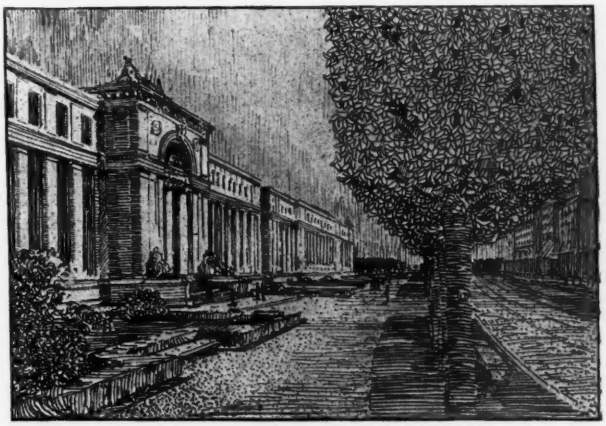
GROUND PLAN FOR THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

THE LIBRARY AND EDUCATION BUILDINGS FROM THE CHARLES RIVER.

used in the Harvard Medical School, has been applied as being most consistent with the needs of the work. Here light and air are the essentials and this construction permits the recesses to be almost entirely of glass. At the corners are pavilions, which satisfy the eye as to stability. In the buildings nearest the river, which here present long facades, the pilasters will be two stories in height with the third story really constituting the frieze. In the structures farther back there is an attic above the establature. This succession of buildings increasing in height from front to rear is a distinctive feature of the group, and furnishes grades and lines that converge towards the massive octagon from which rises the drum and its culminating dome.

The courts will be flanked by the department buildings and the latter are to be linked together so as to afford circulation throughout all portions of the vast structure. It will be unnecessary for the student to go out of doors in passing from one exercise to another. The comparatively narrow buildings will receive light from both sides and in addition it is planned to place all the draughting rooms on the top floor. Here, hidden by the parapets, there will be the standard saw-tooth skylights. The unit system is used in the interior, so that partitions can be readily rearranged. The departmtments can be extended as more space is needed and in the rear less expensive construction can be used.

The frontage along the Charles River Esplanade is fifteen hundred feet, while the length along Massachusetts Avenue is about the same. Half of the site is to be devoted to the educational buildings; the other half, to the east, will be for the students and social facilities. It is the intention to develop a dormitory system surrounding the Walker Memorial, gymnasium, commons and other student features.



THE PRATT SCHOOL OF NAVAL ARCHITECTURE AND THE MASSACHUSETTS AVENUE FACADE.

In the educational group the school of architecture will occupy the right angle at the corner of Massachusetts Avenue and the esplanade, the bridge being really a part of the avenue. On the third side of the court will be civil engineering, running parallel with the esplanade. Continuing along Massachusetts Avenue will be the Pratt School of Naval Architecture and Marine Engineering. Within the interior court behind the Pratt School is the great auditorium. Parallel with the Pratt School and bordering the central court will be hydraulic engineering and

beyond this, mechanical engineering, with space for enlargement. This expansion will be towards the back of the grounds and towards the railway. Near this will be placed the laboratories that involve the handling of very heavy weights and the power plant.

Coming again to the esplanade the buildings that surround the minor court to the east will be devoted to general studies and biology, the latter occupying the inner wing parallel with the esplanade. Chemistry will occupy the long building on the farther side of the great court and mining, engineering and metallurgy will occupy the northeast corner. Electrical engineering finds its place behind the general library, and this situation will permit its incomparable collection of books to be essentially a part of the general library.

THE POSITION OF PROFESSORS IN THE MEDICAL SCHOOL

THE Johns Hopkins University has played a great part in the development of higher education and scientific research in the United States. When Johns Hopkins established a university in Baltimore, he presumably had in mind an institution for boys of Maryland and the south such as Princeton or Amherst, but through the initiative of its first president, Daniel Coit Gilman, a university was created of the kind that has given Germany its leadership in scholarship and research. Each of the first professors—Gildersleeve in Greek, Sylvester in mathematics, Rowland in physics, Remsen in chemistry, Martin in physiology—was a man of distinction called to advance his science in his own way. Buildings, administration and routine teaching were subordinated to the personality of such men.

An advance of equal importance was made by the same university when the medical school was opened in 1893 and placed on a true university basis. Chiefly under the guidance of Dr. William H. Welch a faculty of distinguished men was brought together, and only students—including women, it may be noted—were admitted who were adequately prepared. At that time nearly all the medical schools in the United States were proprietary institutions conducted by the professors for the financial profit which the connection gave them in their practise. The Johns Hopkins University placed the laboratory sciences—physiology, anatomy and pharmacology—on a proper basis, and Dr. Welch led the way in this country in giving pathology a similar status. The clinical chairs were also filled by men of distinction, such as Dr. Osler and Dr. Halstead, and the medical school and the hospital formed an integral institution.

Other universities, notably, Harvard, have followed the lead of the Johns Hopkins Medical School, and remarkable progress has been made in medical education and research in the United States in the thirty years which have elapsed since the opening of the school in Baltimore. But in this country, as in Great Britain, and to a large extent in Germany and France, the professor who teaches in the medical school and has charge of the wards in the hospital, receives no salary or a nominal salary for these services and earns his living by his private practise. A few exceptional men have the force of character which enables them to limit their practise to cases which it is desirable for them to see in the interest of their university work. As a rule, however, the reverse holds and the university and hospital position is sought and used to promote a private practise and a large income. When a university professor travels forty-eight hours in the train for a consultation, one may be pretty sure that it is for the fee rather than for the service or for the experience.

At the present moment the Johns Hopkins Medical School and Hospital are undertaking to reform this unsatis-

factory state of affairs. The General Education Board, endowed by Mr. John D. Rockefeller, has appropriated about one and a half million dollars to establish a William H. Welch fund. The revenue is to be used to enable the school to reorganize the departments of medicine, surgery and pediatrics so that the professors and their associates in the clinics and the laboratories shall be able to devote their entire time to their work. They are free to see and treat any one, whether inside or outside the hospital, but they will accept no personal fee for any such service.

The situation is clearly one of great difficulty. The professor of medicine or surgery may earn fifty to a hundred thousand dollars a year by his private practise. If he relinquishes this for a salary of $10,000, the income may appear ample to the young physician, but scarcely so to the consultant, to whom the automobile has become one of the necessaries of life. If the salary is made larger than $10,000, an apparent injustice is done to the professor of physiology or Greek having equal ability. Then any socialistic scheme of this character limits the freedom of action of the individual, and under the existing system of university organization the limitation may be irksome and may even be subject to a serious trade risk. There is danger lest the ablest men may not want the professorships in the medical schools under such conditions.

Still the movement is surely in the direction that must ultimately prevail. The physician should be paid by the state to preserve health rather than be employed by the patient for a service which it is usually beyond his power to provide. In the face of opposition from the larger part of the profession the British government has this year provided a wide-reaching system by which the physician is largely paid by the state in accordance not with the number of visits he makes, but in proportion to the number of persons who select him. It may be that before long under the control of the state officers of our railways and industrial trusts will receive salaries on condition that they do not engage in outside business. A medical school and hospital which provided the best attainable medical and surgical skill could properly charge the rich fees in accordance with their incomes and earn large amounts to be used for medical research and the promotion of the health of the community. It might not be advisable for all medical schools to adopt the qualifications for students and professors of the Johns Hopkins school, but it is well that there is at least one such institution in the United States.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. Philip Reese Uhler, since 1891 provost of the Peabody Institute, Baltimore, known for his contributions to entomology and geology; of Dr. Charles McBurney, formerly demonstrator of anatomy and professor of surgery in the College of Physicians of Columbia University; of Sir William Preece, the distinguished British electrical engineer; and of M. Charles Tellier, the inventor of the cold storage system.

IT is announced from Paris that M. Charles Richet, professor of physiology in the university, has been awarded the Nobel prize for medicine.—Dr. George E. Hale, director of the Mount Wilson Solar Observatory, has been elected an honorary fellow of the Royal Society of Edinburgh.

PROFESSOR WILLARD C. FISHER, whose forced resignation from the chair of economics and sociology at Wesleyan on the alleged ground of his views on Sabbath observance will be remembered, has been appointed lecturer on economics at Harvard University for the current academic year.

IN connection with the Sixth International Congress of Mathematicians, to

be held in Stockholm in 1916, King Gustav V., of Sweden, has founded a prize, consisting of a gold medal bearing a portrait of Weierstrass and a cash sum of 3,000 crowns, for the best contribution to the theory of analytic functions.

THE American Association for the Advancement of Science and its affiliated societies will meet at Atlanta, Georgia, beginning on December 29, Dr. E. B. Wilson, professor of zoology, Columbia University, is the president for the meeting, and the address of the vice-president will be given by Dr. Edward C. Pickering, of the Harvard College Observatory. Other scientific societies will meet in different places; the zoologists in Philadelphia; the geologists in Princeton; the anthropologists in New York and the psychologists in New Haven.

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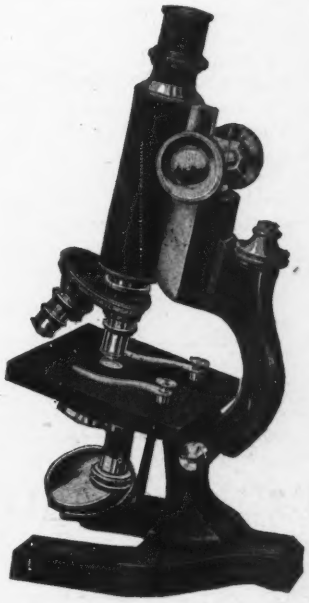

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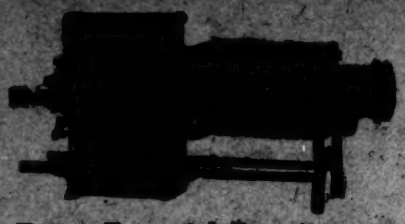

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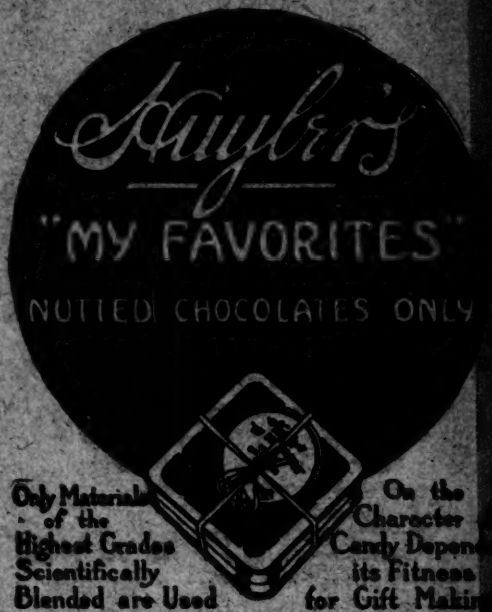

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